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PONDS FOR CLIMATE



Deliverable D1.1

Evaluation and implementation framework protocol for policy, socio-economic and financial analysis of pond nature-based solutions

Pond Ecosystems for Resilient Future Landscapes in a Changing Climate

Horizon2020
European Union Funding
for Research & Innovation

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No ID 869296

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Document title: Deliverable D1.1 - Evaluation and Implementation framework protocol for policy, socio-economic and financial analysis of pond nature-based solutions
Document Type: Deliverable

WP No: 1
WP Title: Project management
WP Lead: UU

Date: 1 July 2021
Document Status: Final version

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No ID869296

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Executive Summary

Pondscapes are important Nature-Based Solutions for climate mitigation and adaptation, as well as in biodiversity conservation, but they are neglected in water- and nature-related national and EU policies and strategies. There is also limited knowledge on the relationships between pondscapes' biodiversity and Ecosystem Services (ES)/ Nature's Contributions to People (NCP) delivery. The mission of the PONDERFUL project is to increase the understanding of the role of pondscapes in providing NCPs/ES and to promote greater implementation of pondscapes as NBS in order to mitigate or adapt to the current trends of environmental deterioration. PONDERFUL will quantify the relations between biodiversity, ecosystem state, ES/NCP and climate change (CC), develop scenarios for climate mitigation and adaptation using pondscapes, and test the implemented pondscape-based solutions using DEMOnstration sites (DEMO sites) co-developed with stakeholders. Ultimately, PONDERFUL will develop practical tools for creating and managing pondscape Nature-Based Solutions.

Work Package (WP) 1 of the PONDERFUL project will develop a multidimensional framework that supports the effective, efficient, and equitable implementation of pondscapes as NBS for CC mitigation and adaptation, biodiversity conservation, and other ES/NCP. The ultimate aim of WP 1 is to support development of guidance and practical implementation of NBS pondscapes. WP1 activities will primarily focus on the project's DEMO sites, and will involve the gathering and integrating social, policy, economic and financing data. By assessing the social, economic, policy and financing aspects of pondscapes, the work within WP1 will provide results that will support broader application of pondscapes NBS, thereby contributing to the overall objective of PONDERFUL.

The aim of the Framework presented in Deliverable 1.1. is to provide overarching guidance for the stakeholder engagement, and social, policy, economic and financing work in DEMO sites, i.e. the activities coordinated by WP1. This report frames the WP1 work in relation to key theoretical concepts that are necessary to understand the WP 1 activities in PONDERFUL. It focuses on the trans- and interdisciplinary aspects of PONDERFUL to explain WP1 research questions, objectives, models and analysis in a language that is understood by all project partners (including not only social scientists, but also natural science partners) and external stakeholders. This is an initial step, which will then be refined and

improved during the project and developed into the final PONDERFUL Framework that will be presented in Deliverable 1.6 by the end of the project.

The Deliverable 1.1. frames the WP1 work in relation to key theoretical concepts that are necessary to understand the WP 1 activities in PONDERFUL and presents how WP1 will work throughout the four years of the project to investigate these barriers and propose potential opportunities to overcome them. This Deliverable is thus broken into two sections: Section 3 ("Challenges to and opportunities for pondscapes implementation") explains WHY we are carrying out our work in WP1, motivating our work by explaining the current socio-economic and policy challenges and barriers to pondscape implementation; section 4 ("PONDERFUL WP1 work") explains HOW we will organise WP1 work to make sure it is efficient, low-cost for DEMO-site partners, including a clear description of how we will interact with others in the project, and what we will demand from them. Section 3 and 4 have been developed based on a structured template that was filled with information about each task from Task 1.3 to 1.6. The filled templates for each task are included in Annex 1.

The assessment procedures presented in this Deliverable are subject to change, as they will develop throughout the project. This is because we are undertaking novel work concerning pondscapes that has to date not been done and there is a need to test how to best approach our research questions.

1. Introduction

1.1 The PONDERFUL project

The PONDERFUL project focuses on the role of ponds, and their congregations, i.e. pondscapes (networks of ponds) in the delivery of different Ecosystem Services (ES) and Nature's Contributions to People (NCPs). Particular attention is paid to pondscapes', as Nature-Based Solutions, role in climate mitigation and adaptation, as well as in biodiversity conservation. Ponds are, both globally and in Europe, the most numerous water bodies. Collectively, small water bodies dominate both water area (30-50% of standing water worldwide (Downing et al. 2006, Biggs et al. 2017)) and contributions to aquatic biodiversity (e.g. supporting 70% of the freshwater species pool in European landscapes (Williams et al. 2004, Davies et al. 2008)).

In spite of their great ecological importance, ponds are largely neglected in water- and nature-related national and EU policies and strategies (Biggs et al. 2017). This is problematic, as ponds are exposed to the same threats as larger bodies of water (e.g. land and water use, pollution, invasive species) and may be particularly vulnerable to climate change, being less buffered to temperature extremes and changes in hydrology (Biggs et al. 2017, Gozlan et al. 2019). That impacts both their number and state (e.g. changes in hydro-period, water level, salinization and eutrophication) (Gozlan et al. 2019). It is important to investigate the relationships between pondscapes' biodiversity and ES/NCP delivery, particularly as the supply of these services are likely to dramatically change with the ecological status of ponds and ongoing climate change.

PONDERFUL will quantify the relations between biodiversity, ecosystem state, ES/NCP and climate change (CC), develop scenarios for climate mitigation and adaptation using pondscapes, and test the implemented pondscape-based solutions using DEMOnstration sites (DEMO sites) co-developed with stakeholders. Ultimately, PONDERFUL will develop practical tools for creating and managing pondscape Nature-Based Solutions (NBS).

The mission of the PONDERFUL project is to increase the understanding of the role of pondscapes in providing NCPs/ES and to promote greater implementation

of pondscapes as NBS in order to mitigate or adapt to the current trends of environmental deterioration.

1.2 Work Package 1: Stakeholder involvement, policy, socio-economics, and sustainable financing

Ponds and freshwater bodies are affected by socio-economic factors, including public policy, economic and financial incentives, and social perceptions of ponds. These socio-economic factors can drive implementation and protection of pondscapes, or place barriers in their way, or drive their deterioration or destruction. WP1 aims to understand how policy, finance, economics, and public perceptions affect ponds, and to identify how these levers can be used to increase the implementation of high-value pondscapes as a nature-based solution to many societal challenges, including by mitigating or adapting to climate change, and providing biodiversity protection.

The overarching aim of Work Package (WP) 1 of the PONDERFUL project is to develop a multidimensional framework that supports the effective, efficient, and equitable implementation of pondscapes as NBS for CC mitigation and adaptation, biodiversity conservation, and other ES/NCPs.

The rise of nature-based solutions to the environmental policy agenda has been followed by a search for suitable frameworks to evaluate their impact. The objective of evaluation frameworks is to assess the performance and impact of diverse types of NBS, ideally using common indicators and methods that make it possible to compare NBS on equal footing with one another or to current practices or alternative management approaches. Evaluation also helps formulate convincing messages about the ability of NBS to meet objectives and deliver societal benefits, and thus promote their adoption.

The European Commission (2021) has recently created an assessment framework for NBS. Its key features are: 1) the development and execution of robust NBS monitoring and evaluation plans, 2) the review and selection of methods for the development and application of impact indicators and 3) scope the acquisition and management of relevant data (EC, 2021). The EC assessment framework furthermore categorizes the impact of NBS in relation to twelve societal challenges,

one of which is Water Management and Climate Resilience. The potential of pondscapes as NBS to address this challenge will be investigated during the PONDERFUL project.

A difficulty in developing impact assessment frameworks for NBS is selecting general objectives against which different NBS can be evaluated and subsequently compared. NBS deliver multiple benefits and there is no widely accepted measure of their performance. Some assessment frameworks may prioritize environmental outcomes as key performance indicators for NBS (e.g. increased biodiversity, water quality or resilience to climate change); others may focus on their social impacts (e.g. leisure and recreation, well-being); still others might give most value to economic efficiency (e.g. the ability of NBS to deliver net benefits to society as a whole).

The PONDERFUL project develops and applies a multidimensional assessment framework for pondscapes as NBS. Its objective is to support the effective, efficient, and equitable implementation of pondscapes. Adjusting Angelsen's (2009) definitions to the scope of PONDERFUL, the effectiveness of a pondscape is their ability to supply benefits for mitigation and adaptation to climate change, biodiversity conservation, and other ES. Efficiency refers to the costs and value for money of pondscape NBS, allowing to compare them to alternative approaches designed to reach the same objectives. Equity refers to the distribution of these costs, as well as benefits. Benefits must be shared and costs distributed fairly in the implementation of pondscapes as NBS.

The PONDERFUL WP1 Assessment Framework has been developed with the objective to clarify (and where possible, quantify) not only the effectiveness of Pondscapes as nature-based solutions; but also consider their efficiency and equity. PONDERFUL is the first attempt at assessing the effectiveness, efficiency and equity of pondscapes as NSB. The framework is multidimensional, because it considers the following four assessment criteria: 1) social acceptability, 2) policy implementability, 3) financing potential and 4) economic efficiency (see figure 1 below). Regarding the social issues, the concept of Nature's Contributions to People (NCP) will be used to describe the needs and the expectations of residents and stakeholders. Ultimately, PONDERFUL seeks ways to offer robust advice concerning the implementation pondscapes as NBS based on a comprehensive evaluation including all important (but often neglected) criteria.

PONDERFUL is also working closely with the Horizon 2020 NBS Cluster Taskforces with the aim to strengthen networking, sharing knowledge, harmonising approaches and building synergies with other related projects and increase the PONDERFUL's impact on NBS.

The overarching aim and specific tasks of WP 1 are captured in figure 1.

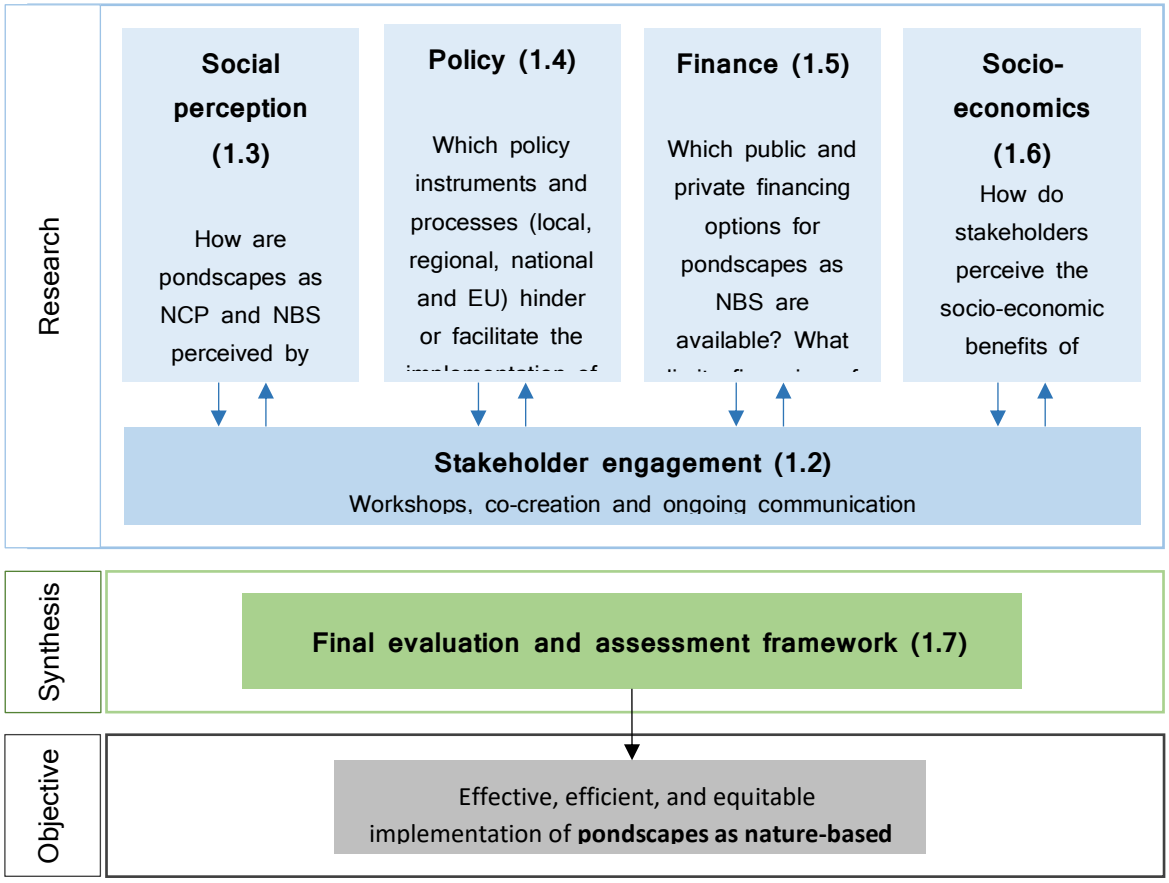

Figure 1. The overarching aim and specific tasks of WP 1.

The objectives of WP 1 are summarised below:

1.1. Provide, in collaboration with all project participants, the conceptual standardisation for the PONDERFUL project work.

1.2. Organise and co-design a multi-actor approach for the project's stakeholder interaction in collaboration with all WPs, with stakeholder mapping, organisation of stakeholder workshops and other stakeholder communication

1.3. Develop the evaluation and implementation framework for pondscape NBS to be applied and implemented in all DEMO sites

1.4. Explore the social perception of ponds and their importance for delivery of ES/NCP

1.5. Analyse pond policy context at multiple governance level (from EU to DEMO sites) to identify enabling factors and barriers for implementing pondscape NBS, as well as instruments to sustainably finance pondscape NBS

1.6. Analyse the economic context of ponds focusing on the economic assessment of risks associated with ponds NBS

1.7. Synthesise WP1 insights into a final evaluation and assessment framework for pondscape NBS to support practitioners and policymakers

The ultimate aim of WP 1 is to support development of guidance and practical implementation of NBS pondscapes. WP1 activities will primarily focus on the project's DEMO sites, and will involve the gathering and integrating social, policy, economic and financing data.

1.3 Deliverable 1.1: Evaluation and implementation framework protocol for policy, socio-economic and financial analysis of pond nature-based solutions

The aim of the Framework presented in Deliverable 1.1. is to provide overarching guidance for the stakeholder engagement, and social, policy, economic and financing work in DEMO sites, i.e. the activities coordinated by WP1. The Framework presented in Deliverable 1.1. is an initial Framework, which will then be refined and improved during the course of the project and developed into final PONDERFUL Framework that will be presented in Deliverable 1.6.

The Deliverable 1.1. frames the WP1 work in relation to key theoretical concepts that are necessary to understand the WP 1 activities in PONDERFUL. It focuses on the trans- and interdisciplinary aspects of PONDERFUL to explain WP1 research questions, objectives, models and analysis in a language that is

understood by all project partners (including not only social scientists, but also natural science partners) and external stakeholders.

WP 1 work focuses on the challenges to effective, efficient, equitable pondscape implementation, as well as to opportunities for the use of pondscapes as NBS. The PONDERFUL Deliverable 1.1 presents how WP1 will work throughout the four years of the project to investigate these barriers and propose potential opportunities to overcome them. In addition, the objective of this Deliverable is to facilitate the conceptual integration across WP1 tasks (aligning research questions and assessment procedures), but also to explain the proposed social sciences research questions, objectives, models and analysis in a language that is understood by our natural sciences partners. This includes explaining to others in an easy to follow language the basics of what WP1 is going to do in particular tasks and why. As such Deliverable 1.1. constitutes an important base for PONDERFUL's work and is a first step in developing the project's Final Assessment Framework to be presented in the Deliverable 1.6 (Overcoming policy/financial/social/economic barriers to pondscape NBS for climate change mitigation and adaptation, delivery of other services, and biodiversity conservation - A synthesis and final PONDERFUL Framework).

This Deliverable is broken into two section: Section 3 ("Challenges to and opportunities for pondscapes implementation") explains WHY we are carrying out our work in WP1, motivating our work by explaining the current socio-economic and policy challenges and barriers to pondscape implementation; section 4 ("PONDERFUL WP1 work") explains HOW we will organise WP1 work to make sure it is efficient, low-cost for DEMO-site partners, including clear description of how we will interact with others in the project, and what we will demand from them. Section 3 and 4 have been developed based on a structured template that was filled with information about each task from Task 1.3 to 1.6. The filled templates for each task are included in Annex 1.

1.4 The context of PONDERFUL and WP1 work

We are currently facing many global challenges, key ones being biodiversity decline and climate change, both having important consequences for humans (Cardinale et al. 2012, IPBES 2019). Biodiversity decline, driven by population

growth, land use change, habitat fragmentation and climate change, continues, even if numerous policies, initiatives and projects have been implemented during the last decades to counteract this trend (IPBES 2019). This is worrying, because functioning ecosystems based on rich biodiversity are a prerequisite for human survival and well-being (Daily 1997, Harrison et al. 2014), as biodiversity contributes to the delivery of numerous ES or NCP. Climate change aggravates biodiversity decline, as it puts pressure on ecosystems through increases in extreme weather events such as floods, droughts and storms, desertification of some areas, as well as changes in average temperatures and precipitation. It also leads to an increase in new pests and invasive species and novel contexts of community interactions. This forces species to adapt or migrate, which not all are equally capable of (Merilä and Hendry 2014). All of these factors, in turn, have impacts on human well-being, e.g. in terms of food security, heat stress, zoonotic diseases or potential conflicts). At the same time, more resilient ecosystems, i.e. ecosystems that can withstand different disturbances, have the potential to mitigate the effects of climate change and to help us adapt to its consequences (Loreau et al. 2003; Yachi and Loreau 1999).

In relation to the above, pondscapes are crucial. They provide important habitats for rich biodiversity, which is a prerequisite for delivery of many ES/NCP. While individual ponds may seem not that important when compared to larger water bodies, such as lakes or rivers, collectively they represent 30-50 % of the global freshwater area (Downing et al. 2006, EPCN 2008, Biggs et al. 2017).

Ponds are crucial for biodiversity conservation, in fact supporting a larger proportion of rare, endemic and threatened freshwater species than lakes or rivers (Williams et al. 2004). They are also key elements of blue landscape connectivity, acting as stepping stones between freshwater water habitats (Davies et al. 2008). Networks of ponds support the metapopulations of many aquatic species, such as invertebrates, amphibians and aquatic plants, and are thus important in supporting regional biodiversity. Ponds may also have the potential to play an important role in climate regulation, as they have the potential to sequester large amounts of carbon in their sediments (Taylor et al. 2019). However, they can also be a source of greenhouse gases (Holgerson et al 2016). The role of ponds in relation to climate change needs to be further explored and quantified. In addition, ponds deliver ES/NCP such as water provision, flood control, freshwater recharge, pollution amelioration and recreation. In addition to these often invisible societal

benefits, they matter to human well-being because they provide a space for leisure, inspiration and learning.

Because of their role in supporting biodiversity and delivering crucial ES/NCPs to people, ponds can help with climate change adaptation and mitigation. Using ponds is thus, as opposed to the use of grey infrastructure, a way of using nature to deliver diverse solutions to environmental problems, i.e. Nature-based Solutions (NBS).

NBS are solutions that are inspired and supported by nature. These solutions have the ability to simultaneously provide environmental, social and economic benefits and can help to build resilience. Furthermore, NBSs increase diversity and amounts of nature and natural features and processes in cities, landscapes and seascapes. They are locally adapted, resource-efficient and systemic interventions (EC 2021, Science for Environment Policy 2021) and likely to be more cost effective than their grey infrastructure alternative.

The pondscape NBS considered for PONDERFUL are:

- Pond creation (e.g. digging a pond in a place where there was formerly no waterbody).
- Pond restoration (e.g. digging a pond in a place where formerly a pond was existing; regenerating a landfilled pond; undertaking important transformations on an existing pond)
- Management measures. They can be implemented at the pond level (water body scale) or surrounding landscape level (pondscape level).

Table 1 presents several examples of NBS. This list will be updated in relation with the pond/pondscape NBS inventory realized in the framework of Task 4.1.

Table 1. Categorisation of pond and pondscape NBS

NBS: broad type and description
1. Pond creation • Creating a pond in a site where there was formerly no waterbody
2. Pond restoration

- Creating or restoring a pond in a site where formerly a pond was existing, e.g. excavating a pond that had been filled in
- Significant alterations to an existing pond, e.g. depth, morphometry, slopes, shoreline design, flora or fauna

3. Pond infrastructure and management actions

These refer to those on-site infrastructure and management actions that are needed to ensure the appropriate functioning of an individual pond.

On-site infrastructure measures ***(acting on areas immediately surrounding pond)***:

- **o** Access restrictions, e.g. fencing to prevent access by livestock, dogs, or visitors - or removing fencing to allow livestock access
- **o** Development of trails or wildlife observatories
- o Management of riparian vegetation and wetland plants
- o Removing invasive alien plant species
- o Implementing (or enlarging) the buffer area immediately surrounding the pond
- o Creation of terrestrial habitats in the vicinity of the pond (e.g. for reptiles or amphibians)
- o Removing hard infrastructure (e.g. concrete edge)
- …

Pond management measures ***(actions within pond)***:

- **o** Removing invasive alien plant and animal species
- o Removing of all fish
- o Reintroducing or protecting threatened plant and animal species
- o Pond water management, e.g. manage input, output (e.g. sluice repair or adjustments, lining), drying rate
- o Routine management measures in relation with the pond design and depth (e.g. slight re-profiling of banks, removal of sediments, creation or removal of an island, scraping edges to maintain populations of pioneer species)
- o Mowing and removal of submerged, floating or emergent plants
- o Regular monitoring of physical, chemical or biological indicators
- o Planting or introducing structured vegetation into ponds (e.g. planted coil rolls)
- o Shade management (e.g. a few trees or large % of cover)

- Part-desilt
- …

4. Pondscape scale land use and management actions

These refer to those on-site land-use actions that are needed to ensure the appropriate functioning of a pondscape (ponds and surrounding landscape)

Placing the pondscape (or a part of the pondscape) under protective status (e.g. protected areas regulations)

Changing land use in the pondscape and in the area surrounding the pondscape (e.g. convert arable land or intensive livestock grazing area to extensive grassland; decrease impervious surfaces e.g. asphalt in neighboring areas).

Enhancing the connectivity between ponds or pondscapes. This involves the creation of terrestrial or aquatic corridors, removing obstacles, or active transport of propagules.

Specific pondscape management measures, depending on landscape (within and surrounding the pondscape):

- In agricultural land, other pondscape related management measures: 1) Soil Management (e.g. Allow field drainage systems to deteriorate or reinstate/increase infiltration to decrease sediment load), 2) Livestock Management (e.g. Reduce the length of the grazing day or grazing season), 3) Fertiliser Management (e.g. Reduce fertiliser application rates), 4) Manure Management (e.g. change from slurry to a solid manure handling system) and 5) Farm infrastructure (e.g. Fence off pondscape from livestock)
- In urban land, 1) Manage water quality (e.g. inputs of nutrient, salt, other pollutants); 2) Increase good quality terrestrial habitats in neighbouring areas (e.g. other green/blue spaces); 3) Promote natural hydroperiods, 4) Encourage water harvesting from buildings (rainwater)
- ….

In the assessment of ponds' biodiversity, ecosystem functions and services, and their interaction with society, it is important that spatial scale is taken explicitly into consideration. In addition to the individual pond, whose condition can be improved by local management, the "pondscape", as the set of ponds in a given landscape, plays an important role. Connectivity of ponds in the landscape or region, amongst others determined by the density of the ponds, will affect local persistence of

species populations, metacommunity structure and regional diversity (Davies et al. 2008). As such there is a strong potential for interaction between the local and regional level - with a higher density in high quality ponds supporting local biodiversity through enhanced connectivity and sources for species immigration, while regional diversity is supported by local habitat quality (Deacon et al. 2018, Biggs et al. 2019). Pondscapes can refer to specific sets of ponds in the landscape, or any area of interest - either defined by ecology (catchment area, floodplain, valley, etc.) or by societal or political borders (urban pondscape, provincial or national borders).

Pondscapes constitute socio-ecological systems with relations and feedbacks that operate at multiple spatial scales. Ecological systems are complex and how they behave depends on many interactions between their different components. They are also continuously changing and adapting to changing conditions (Levin et al. 2013). At the same time, ecological systems are strongly interconnected with social, political and economic systems, as human activities and decisions impact the management and state of ecosystems. Thus, many different stakeholders are engaged in decision-making regarding ecosystems and impact ecosystems in various ways. This is of course also the case for pondscapes and thus to implement them on a larger scale and manage them in a way that promotes their benefits requires broad engagement of different actors. These actors operate at multiple spatial and governance scales and represent different sectors and areas of interest. They could be authorities and decision makers at levels from local to international (e.g. EU), NGOs, representatives of academia and private actors as well as land owners and land owner organisations.

Because the ecological and social systems of pondscapes are intertwined, to manage and plan for their sustainability it is important to understand the policy context (e.g. existing governance arrangements, policy instruments, etc.) in which they are embedded and learn about decision making processes that are involved in, including possibilities for financing of pond creation and management. It is also important to understand social perceptions of the benefits that pondscapes deliver, including gender differences in these perceptions, as well as how these benefits are valued.

Because ponds and their role for societies has been to date largely neglected in policies and action on the ground, there is an urgent need to promote their broader uptake as Nature-Based Solutions that address ongoing climate change

and biodiversity decline (Williams et al. 2020). The mission of PONDERFUL is to raise understanding about the potential value delivered by pondscapes and to facilitate their broad application in Europe and beyond. However, there are numerous barriers that need to be first overcome to achieve that. Such barriers come from the socio-political system the pondscapes are embedded in. For example, the policy context may not be well adjusted to the need for implementing ponds, as there can be a lack of adequate policy instruments, including proper financing to support ponds creation or management, or stakeholders may not be interested in ponds or aware of the benefits they provide.

2. Challenges and opportunities for pond implementation

As pondscapes are complex socio-ecological systems, application of ponds as NBS requires that considerations are given to numerous dimensions. First, decisions regarding pondscapes are taken by a wide range of stakeholders who have different levels of interest in ponds and NBS, and different possibilities (power) to influence them. Second, different stakeholders may perceive and value ponds in different ways and prioritise various ecosystem services they deliver. Third, ponds are being created and managed in a specific policy context that can influence possibilities for their use. For example, options for financing of pondscapes need to be available. Finally, various stakeholders can perceive socio-economic benefits from pondscapes in different ways and different types of pondscapes can provide the particular benefits with different efficiency.

As such, the work of WP 1 is complementary to the work of other WPs in PONDERFUL - ponds cannot only be assessed in terms of their ecological effectiveness (WP2 and WP3), but there are also other questions at play in relation to their implementation. Policy barriers, financing, social perceptions and values - all need to be also considered in the range of criteria that can lead to their selection as NBSs. WP1 captures all these dimensions.

In this section of Deliverable 1.1. we provide an overview of the rationale behind the WP1 work on each of the dimensions described above, while in the next section we explain how WP1 will work to assess them, to help overcome the key implementation barriers.

2.1 Stakeholder engagement (Task 1.2)

Stakeholder involvement is an important part of the PONDERFUL work and starts early on, to enable their meaningful contribution to the project. In the case of PONDERFUL, relevant stakeholders are groups of individuals that can affect or be

affected by policy decisions that are relevant for pondscapes. Such decisions do not need to directly consider ponds or pondscapes as such, but could be e.g. decisions in different sectors that have impact on pondscapes, e.g. decisions in nature conservation sector, decisions concerning climate change, spatial planning decisions, management decisions (e.g. about creation and/or maintenance of ponds). Relevant stakeholders include both public and private stakeholders.

There are many important reasons to include stakeholders both in the project, and in the work on the ground, such as creation of ponds and planning for their management. Stakeholder participation can empower stakeholders through the co-generation of knowledge with researchers and increasing participants' capacity to use this knowledge. Participation may also make research more robust by providing higher quality information inputs, including contextual information. Local stakeholders are often important sources of data, insights and ideas that can be useful for researchers. In addition, participation of stakeholders facilitates trust building and help establish common ground. It may increase the likelihood that environmental decisions are perceived to be holistic and fair, accounting for a diversity of values and needs. Also, it enables interventions and technologies to be better adapted to local socio-cultural and environmental conditions, which may enhance their rate of adoption and diffusion among target groups, and their capacity to meet local needs and priorities (Reed 2008).

In PONDERFUL we will engage with a wide range of stakeholders (e.g. public authorities at local to national levels, land managers, farmers, NGOs; see also section on stakeholder mapping), to gather information relevant for the social, policy and finance aspects of the project, discuss baseline scenarios and co-develop future positive scenarios, co-create resources to be used by practitioners and policy makers, and communicate and disseminate the project's results. This work will be important to understand stakeholders' needs and priorities regarding ponds and their ES/NCP and the socio-political context they are embedded in. At the same time, this work will support pondscape management and identification of shared goals of different stakeholders. This will help to increase acceptance of pondscapes and awareness of their benefits among stakeholders and provide them with knowledge and tools to allow them to better plan for their pondscapes in the future.

2.2 Social perception of ponds (Task 1.3)

This section presents a summary of the key issues and stakes of the task 1.3. The research question deals with the role of social and geographic aspects in the management of the pondscapes (Boothby, 1997) chosen by the PONDERFUL project.

The objective is to examine the extent to which the local population and the stakeholders evaluate the role and the environmental state of these pondscapes. Local knowledge (Mathé, Rey-Valette, 2015) and perceptions (Bastien et al., 2011; Blayac et al., 2014) are often important element to identify the conditions for preserving ponds and pondscapes. The knowledge of perceptions and expectations of these actors facilitates incentive mechanisms based on actors' endogenous motivations to preserve pondscapes. The study of the perceptions is a necessary step to understanding all the reasons underlying the interest to conserve the pondscapes. Gathering the reactions and perceptions (including gender differences) enhances the effectiveness and legitimacy of environmental restoration with taking account of the diversity of viewpoints in order to identify all the issues.

However, at this time, no information is yet available about the different DEMO sites. It is therefore not known how local actors feel about ponds and pondscapes, what they value about them (Jarvie et al., 2017) and which benefits from pondscapes are most important to them. It is essential for researchers to understand the local context of each DEMO-site and their constraints. Without all those elements, it would be much more difficult to develop effective policy to make pondscapes better for local actors.

In the face of growing societal demand for information and involvement, the analysis of perceptions could help taking social and geographic perspectives into account (Castro et al. 2014; Quintas-Sorian et al., 2018). The identification of values of ponds and perceptions provides the basis for prioritising the most important social and environmental stakes in regard of local actors (López-Rodríguez et al., 2015). Indeed, perceptions and preferences depend on the social and cultural context. For example, meeting the specific needs of local actors could contribute to cultural heritage, wetland restoration or biodiversity conservation.

This identification of perceptions phase plays a major part in the acknowledgment of the contributions of ponds and pondscapes. Studies rarely address how resident and stakeholder perceptions link to the biophysical properties and functions of the ponds and pondscapes. The overlap between local actors' needs and nature's perception is considered more important to the successful completion of this study. To this end, we will use the concept of Nature's Contributions to People (NCP) proposed by Diaz et al. (2018, IPBES). NCP are all the contributions, both positive and negative, of living nature to people's quality of life. Many NCPs may be perceived as benefits or detriments depending on the cultural, socioeconomic, temporal, or spatial context. This notion considers the socio-cultural dimension, through the identification of all links between society and nature.

Diaz et al. (IPBES) proposed 18 different types of NCPs, which are not all necessarily relevant to ponds. During the development of the project PONDERFUL (2018-2019), the list of 18 types of NCPs was therefore filtered according to their relevance for pondscape, and narrowed down to a final list of 11 NCPs. A list of these 11 types of NCPs selected to determine the values they provide and how they impact quality of life is presented in Figure 2.

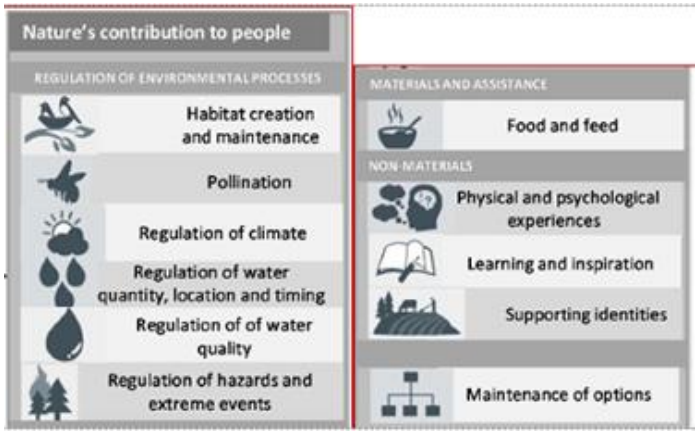

Figure 2. List of the 11 types of NCPs selected for the assessment of pondscapes in the framework of PONDERFUL.

To say a few words about NCP in the framework of the perception analysis, this notion is interesting in the sense that we are able to identify all the categories of impacts and contributions of pondscapes and take account of the socio-cultural dimension in the identification of all links between society and nature. We consider the use of the NCP' concept to provide a clear picture of the present in each pondscape and to produce an exhaustive inventory of existing expectations of local actors regarding the potential contributions. Potential contributions describe how nature could impact people and their quality of life. The concept of "quality of life" was defined as follows: « *the achievement of a fulfilled human life, the criteria for which may vary greatly across different societies and groups within societies. It is a context-dependent state of individuals and human groups, comprising aspects such as access to food, water, energy and livelihood security, and also health, good social relationships and equity, security, cultural identity, and freedom of choice and action* » (Pascual et al., 2017). On this qualitative dimension of contributions, it will be important to emphasize the differences of identification of positive and negative contributions between the eight DEMO-sites in the achievement of the best possible quality of life.

The identification of the impacts of climate change, which can be ranked in order of importance, enables us to assess the share of environmental parameters in the notion of quality of life at territorial level. The task 1.3 is essential for an original assessment of perceptions of pondscapes with an emphasis on the needs for the Nature's Contributions to People (NCP). These perceptions analysis can make a genuine contribution to the quality of life and should guide the implementation of the adaptive measures for tackling climate change.

Previous studies on NCP (Christie et al. 2019, Martín-López et al. 2019) have here been considered to determine the best approach to addressing the pondscapes issues. An effort was also made to understand the differences between the notion of NCP and others notions as Ecosystem Services and Nature-Based Solutions (Dumitru and Wendling 2021). We distinguish the contributions from ecosystem services (Pires et al. 2020, Peterson et al. 2018) by considering the proportion of potential benefit provided by pondscapes. For its parts, the NBS's concept takes place to assess a change of state as a result of implemented measures.

Our study could provide an intermediate step toward defining priority of NBS' implementation and valuing the role of pondscape for the quality of life. The survey findings will provide the foundation for choosing some relevant indicators to adapt NBS and pondscape management to the local social context. In designing the framework of the list of indicators in Work Package 4, the main goal is to match NCPs categories and NCPs indicators. Our bottom-up approach assumes that the needs of the society are a precondition for the success of wise Nature-Based Solutions.

To do this in-depth social study, we have planned a qualitative and quantitative approach with a view to inventorying the perceptions, the local knowledge, the expectations and the feedbacks of previous actions (first NBS' implementation during the last years). We have conceived two questionnaires. The questions relating to the perception of contributions constituted a core module in the two questionnaires. Our survey describes and compare perceptions within and across each Demo Sites and explore how NCPs' perceptions vary among local respondents and among stakeholder groups. Thanks to data analysis, we will establish a typology of social perceptions of pondscapes. Using this typology, we will identify the variability of benefits provided by pondscapes and NCPs priorities. We find it quite helpful for improved development, implementation, and management of pondscapes. The close cooperation between the scientists and the stakeholders constitutes a guarantee of a better awareness of the complexity of human-environmental interactions and of a continuing monitoring of the measures.

2.3 Policy analysis (Task 1.4)

As ponds, despite their importance, are largely neglected in river basin management planning, there is an urgent need to incorporate considerations for these small water bodies into key environmental and water-related policies (Hill et al. 2018). In recent years there has been an increasing recognition of the role of wetlands in EU policy making, which might also open up an avenue for discussing pondscapes. Besides passing specific environmental policies, emphasis has been extended to environmental policy integration, that refers to the incorporation of environmental concerns in policy sectors outside of the traditional environmental policy domain, for example agriculture, urban planning or transport. It can

overcome negative environmental outcomes resulting from the institutional specialization of sectoral policy, and make environmental policy more effective.

Clearly defined local targets for the future of pondscapes are important to motivate effective action and to enable policymakers and stakeholders to evaluate the effectiveness of potential management decisions. Such policy targets need to integrate concerns of different sectors, as pondscapes impact and are impacted by the policies, regulations and strategies of different sectors, e.g. water, agriculture, energy or conservation sectors. To incorporate specific concerns about pondscapes in different sectoral policies, there is a need for using policy instruments and approaches that support the use of pondscapes as NBS, as well as to explore the discourses the respective policies perpetuate. However, little is known about which policy instruments, approaches and processes can either support or hinder implementation of pondscapes. Thus, the key role of the Task 1.4 is to analyse pond and pondscape-related policy context, from EU, to DEMO-site level and identify existing instruments and approaches to implementation of NBS.

The policy inventory and local policy analysis will reveal existing policy factors, including different instruments, that can facilitate creation and management of pondscapes NBS. In addition, it will explore pond and pondscape implementation barriers. This all will contribute to final recommendations on what can be improved in the policy and decision-making processes to support broader implementation of pond and pondscape NBS. As such, this Task addresses two key research questions:

1. What are policy factors (including policy processes and instruments, as well as existing data) at EU level that may hinder or facilitate implementation of pond NBS?

What are policy factors (including policy instruments) at local, regional and national levels that may hinder or facilitate implementation of pond NBS?

2.4 Possibilities for financing (Task 1.5)

While not the only challenge, a lack of finance has been identified as one of the main barriers to the implementation of NBS (Faivre et al, 2017). While literature

exists regarding the financing of NBS, little is known about the financial barriers and opportunities in the specific context of pond and pondscape NBS. The aim of this task is therefore to explore the following questions: What are existing and potential financing options for pondscape NBS (both public and private)? What are their strengths and weaknesses? What barriers limit financing of pondscape NBS?

The protection, restoration, and creation of ponds has costs. Upfront costs of restoring and creating ponds can include planning and design costs, the hire of diggers and drivers, land purchase, and planting, as well as the costs involved with changing existing behaviours (e.g. the time involved with learning new land-management approaches or cost of training courses). Ongoing costs can include maintenance, management, and monitoring, as well as the cost of lost income that may have otherwise been earned from the land. PONDERFUL research will supplement the currently limited knowledge on the extent of the costs for implementing pondscapes as NBS in different contexts, which costs can be significant and can pose significant barriers to their uptake.

Moreover, NBS projects are unlikely to be developed and financers will rarely lend or invest in them without a clear business case and proof of concept setting out the costs, benefits, and risk profiles. Clear business cases are also important for accessing public funding. Making a convincing business case is complicated by a lack of examples of financially viable NBS, as well as by project financers' lack of experience with NBS. As a result of this unfamiliarity, NBS are often perceived as riskier than traditional engineering solutions, regardless of their actual risk profile (Watkins et al. 2019). The main challenge in making such as business case relates to calculating and capitalising NBS's diverse benefits, which go beyond direct returns and revenues:

- NBS deliver benefits to multiple beneficiaries. Because the benefits to each beneficiary are small (relative to the sum of benefits - and to the costs), individual beneficiaries may not be motivated to finance ponds, even when they would deliver social net benefits (i.e. the sum of benefits outweighs the costs) (Seddon et al. 2020).
- Many of the NBS benefits (e.g. biodiversity protection, recreational value) are not valued in traditional economic markets, making it challenging to monetize these benefits (Wild et al. 2017).
- NBS deliver benefits over long timescales, which can pose challenges for traditional, short-term sources of funding (Kabisch et al. 2016).

- There is significant uncertainty regarding how ecosystems perform under variable conditions, which is aggravated by data gaps, lack of analytical methodologies and guidance, as well as capacity barriers (Watkins et al. 2019).

These challenges can make it difficult to accurately assess the expected costs and benefits of NBS, or to build convincing business cases (i.e. evidence demonstrating that benefits exceed costs, within a reasonable time period).

The limited number of convincing NBS business cases and the difficulty of monetising benefits is presently discouraging investment, especially from private financers (such as individual landowners, banks, companies) (Naumann and Davis 2020). The lack of private investment leaves NBS implementation at the discretion of available public budgets, indeed, Naumann and Davis (2020) report that 75% of all NBS so far implemented within the EU have been funded by the public sector. To achieve widescale implementation of nature-based solutions such as pondscapes, a clearer understanding of the costs and benefits of NBS and different models to finance them is required.

This need to move beyond public finance has led to a research focus on biodiversity finance, with a view to increase knowledge to increase effectiveness and amount of private investment in the protection of nature. BIOFIN, the UNDP's Global Biodiversity Financing Initiative, defines biodiversity finance as "the practice of raising and managing capital and using financial and economic incentives to support sustainable biodiversity management" (UNDP, 2018). This broad definition takes the perspective of the national policy-maker, capturing all of the levers they have at their disposal to support the widespread protection of biodiversity (and implementation of NBS). Within PONDERFUL, the sustainable finance work will take the perspective of the pond project developer (e.g. regional government, farmers, local NGOs, among others). The aim will be to assess existing and potential funding and financing opportunities for the implementation of pond NBS, highlighting their relative strengths and weaknesses, and relative suitability for different pond project developers.

The financing measures considered will include:

- Grants - i.e. public or other non-commercial funding from governments or other funders;

- Debt/equity - i.e. loans or investment funding from banks or investors, including green bonds;
- Risk management - payments related to a transfer in risk, for example in collaboration with insurance companies or other affected beneficiaries;
- Market options - such as offset certificates or payment for ecosystem services;
- Financial instruments to de-risk projects - such as risk underwriting, provision of guarantees and technical assistance to build investor confidence;
- Other - other potential sources of funding, including collaborative community approaches or other coordination mechanisms.

Ultimately, the sustainable finance work within PONDERFUL is concerned with the question of how to ensure there is sufficient money available to create, maintain, manage or restore pond NBS to protect biodiversity and deliver climate mitigation, adaptation, and other benefits. By identifying opportunities and barriers, we will aim to help overcome the barrier of insufficient biodiversity financing for NBS, and support their most effective, efficient, and equitable distribution.

2.5 Assessing the socio-economic benefits of ponds (Task 1.6)

Small water bodies, like ponds and their congregations, i.e. pondscapes, provide various ecosystem services and Nature's Contributions to People, such as regulating climate, storing carbon, mitigating flood risk and alleviating pollution. The benefits also include improving physical and mental life of local inhabitants by encouraging recreational activities and tourism in some areas.

However, every benefit comes with a cost. In the specific case of a NBS, like pondscapes, there are costs, such as infrastructure capital and maintenance costs, and thus it is questionable whether the benefits of pondscapes can be achieved by covering the associated costs. This comparison is not only used to compare pondscapes among themselves, but also to compare pondscapes with other NBS. Furthermore, these benefits are not perceived equivalently among the different stakeholders within the same pondscape, or stakeholders among different

pondscapes. Therefore, there might be mismatches between the designed functions of a pondscape and the functions that the stakeholders appreciate.

To assess those benefits from a holistic perspective, Task 1.6 contributes to the project by exploring the social perceptions of net benefits provided by pondscapes, understanding the priorities in ecosystem services and identifying best practices that can ensure economic feasibility and biodiversity conservation based on local stakeholder perspective. This task aims to answer the following research questions:

- How can the socio-economic benefits of ponds and pondscapes be quantified?
- How do stakeholders perceive the relative importance of environmental, social and economic characteristics of ponds as NCP? Based on these perceptions, how can pondscapes be ranked?
- How efficient can pondscapes be, not only in comparison with each other but also with other NBS?

3. PONDERFUL WP 1 work

In this section we describe how we will organise the work in WP 1 to make sure it is efficient and of low-cost for DEMO-site participants (see Annex 1).

3.1 Stakeholder engagement (Task 1.2)

To engage stakeholders, numerous activities will be included in the project's work.

First, a comprehensive stakeholder mapping was conducted at the beginning of the PONDERFUL projects, led by WP1 and with contributions from all DEMO-sites, covering main stakeholders in all DEMO-sites, their level of operation, their main roles in relation to pondscapes, their interest in the PONDERFUL project, their power to influence decisions concerning pondscapes, as well as their priorities with regard to different ES/NCPs, as perceived by DEMO-site leaders. The instructions for two steps of stakeholder mapping and general synthesis of the stakeholder mapping is included in Milestone 5: PONDERFUL Concept Note (Annex 2).

Second, three stakeholder workshops will be organised in each DEMO-site, to engage with stakeholders, develop a meaningful communication and collaboration process and build trust between stakeholders and researchers within the project, as well as to gather data and information for particular tasks (Table 2). WP 1 will provide comprehensive guidelines for each workshop organisation, as well as will conduct individual meetings and training with each of the DEMO-sites. WP 1 researchers will also act as support during all workshops.

Table 2. PONDERFUL Stakeholder workshop plan

Workshop	**Key focus of the workshop (with relevant Tasks in the brackets)**	**Number of workshops**	**Responsible participants**	**Timing**
First stakeholder	Scoping stakeholders needs; social aspects (1.3);	8 (each DEMO	Each DEMO site leader (WP4) organises; WP1	M9-12 (August-

workshop	identifying socio-economic and ecological indicators (1.6) and indicators for scenario development (3.3)	site)	(UU and ISARA) and WP3 (BU) provide guidance	November 2021)
	Sustainable financing (scoping, 1.5)	3 (selected DEMO sites)	WP1 organises (ECOLOGIC) in collaboration with DEMO site leaders	
Second stakeholder workshop	Policy analysis (1.4) and scenario development (3.3)	8 (each DEMO site)	Each DEMO site leader (WP4) organises; WP1 (UU) and 3 (BU) provide guidance	M20-26 (August 2022 to January 2023)
	Sustainable financing (option co-creation, 1.5)	3 (selected DEMO sites)	WP1 organises (ECOLOGIC) in collaboration with DEMO site leaders	
Third stakeholder workshop	Discuss preliminary results, incl. scenario maps (3.3) and policy options (1.4). Co-develop information resource set (Technical Handbook with CLIMA-Pond, Guidance Document, decision-making tool) (4.5)	8 (each DEMO site)	Each DEMO site leader (WP4) organises; WP1 (UU),3 (BU) and 4 (HES-SO) provide guidance; WP 5 provides communication support	M34-39 (September 2023 to February 2024)
	Sustainable financing (evaluation and results, 1.5)	3 (selected DEMO sites)	WP1 organises (ECOLOGIC) in collaboration with DEMO site leaders	

Finally, the survey data collected within Task 1.3 will also serve as means of gathering information about stakeholders' priorities, interests and needs that can

then be used in other parts of the project, e.g. In Task 1.6. of WP 1, and in WP4's evaluations of ponds benefits.

3.2 Social perception of ponds (Task 1.3)

Applying an inter-site analysis method, data will be collected through quantitative and qualitative research tools. Our task helps to complement the general understanding by valuing the ideas, opinions and possibilities of the inhabitants and the stakeholders.

We will develop and circulate an inhabitant and stakeholder questionnaires with an opportunity to describe their perceptions and knowledge about the pondscapes of all the DEMO-sites. The survey will also gather information for the socio-economic analysis conducted in Task 1.6.

The subjects addressed are the profile of the respondents (gender, age, type of job, background), the social and geographical closeness with pondscapes (regularity and frequency of on-the-spot visits, distance from the home of visitors), the relation to nature and to the ponds (activities), the knowledge (origin, emblematic species), the perception of changes (change over time), the general assessment of the pondscape (aesthetic scenery, environmental state, idealistic characteristics of a pondscape, main risks), the perception of NCPs (role of the pondscape as a source of well-being) and the perception of NBSs (choices to limit risks, measures to implement).

It is expected then to organise workshops (Table 2. PONDERFUL Stakeholder workshop plan) with the participation of the stakeholders to discuss the results of their answers and about opportunities/threats for the future for improved management. For the organization, we think that face-to-face workshops have to be maintained if possible, because virtual meeting could cause certain problems with regard to the data compilation (due to a lack of interactions). There's a real continuity in the collection of data between both the questionnaire and the implementation of the workshops. We look forward to discussing the results of the questionnaires during the workshop. This will give a good understanding and

description of the differences between the gender, the inhabitants and stakeholders, the ranking of NCPs.

During these two work steps, we will pay special attention to gender equity. If we may not be able to control the gender of the respondents of the resident's questionnaire, we can highlight the differences between the male and female perceptions of pondscapes. Regarding the composition and functioning of the forthcoming workshops, we will strive for maximum transparency and allocate speaking time about this issue.

The success of task 1.3 depends on close cooperation of each DEMO-site. We need them to make contact with stakeholders of each DEMO-Site, to translate, make known and disseminate both the questionnaires, as well as take charge of all practical aspects of the workshops (room, food service…).

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3.3 Policy analysis (Task 1.4)

Task 1.4. contains two key subtasks:

1. EU policy inventory that will be conducted by WP1 partners;
2. DEMO-site policy analysis that will be conducted by WP1 partners with the help of DEMO-site leaders.

The objective of the **EU policy inventory** is to identify policy mechanisms at the EU level that support or encourage pondscapes (their creation, management or restoration) and identify support mechanisms and the underlying policy objectives. In addition, the inventory will explore potential barriers for implementing pondscapes. Such barriers can be, for example, linked to specific priorities of other sectors. EU policy inventory will be conducted through a desk study data gathering and content analysis, and the results will be synthesised in Deliverable 1.3 and in a scientific paper, and will also be used to inform the further policy analysis at the DEMO-site level.

The **DEMO-site policy analysis** will include the following steps:

1. *Stakeholder mapping* to identify key stakeholders relevant for each DEMO-site - the stakeholder mapping process was initiated at the beginning of the project and the results are synthesised in Milestone 5; however, the mapping is a "living" process and more information on particular stakeholders can be added during the project, e.g. when contacts with new stakeholders will be established at DEMO-sites or new information about particular stakeholders will become available.

2. *Mapping socio-economic context* - the DEMO-site leads will be asked to provide basic information about their DEMO-sites, e.g. main land covers, origin of pondscape, land ownership, important sectors at play, population, key issues of interest in relation to ponds, e.g. which NCP are important, what are problems and challenges in this area, etc. This information should be provided as 1-2 pages of text and will serve as background information for the policy analysis.

3. *Mapping policy space* - DEMO-site leads will be asked to provide a list of policies relevant for their DEMO-site and some data about them filled in in the template (e.g. policy sector, type of policy, issuing authority, legally binding or not, main focus, what does it impact, etc.); Task 1.4. leads will provide clear guidance (and examples) on what to deliver and in what form (a template).

4. *Analysis of policy documents at DEMO-sites* - the DEMO-site leads will be asked to conduct policy analysis and fill in a template about them; Task leads will provide detailed instructions for policy analysis, including clear examples, as well as templates to fill in with data (e.g. relevant NCPs; impacts, drivers and responses mentioned/addressed - that can be relevant, e.g. impact pondscapes; instruments/incentives that could support or hinder implementation of ponds/pondscapes). Where possible, Task 1.4 researchers will help with the analysis itself (depending on language of the documents).

5. *Policy interviews with stakeholders* on perceived barriers to pond creation and/or management (based on the policy documents analysis) - the DEMO-site leads will be asked to conduct 5-10 interviews with key stakeholders and fill in a template with data. Alternatively, data could be collected through a group work on workshops in DEMO-sites; Task leads will an provide and a structured interview guide, so it is easy to get responses

that could be summarised in a simple template. Where possible, Task 1.4 researchers will conduct the interviews (depending on language of the documents).

6. *Stakeholder workshop 2*: discussing results of desk study and interviews - the DEMO-site leads will be asked to organise the workshop and filling in the template; Task leads will provide clear and detailed instructions for organising policy session on the second workshop; training and individual discussions with DEMO-sites before the workshop, as well as a template to fill in with data (e.g. scoring of some options by stakeholders as important realistic, etc.)

3.4 Possibility for financing (Task 1.5)

The sustainable financing work undertaken to answer the research question outlined above rests on two pillars: a theoretical investigation based on literature and expert knowledge, as well as on practical work for the development of sustainable financing plans with three selected PONDERFUL DEMO sites.

Theoretical investigation of sustainable finance for pondscapes

1. The first step is a **literature review** of academic and grey literature, which forms the knowledge base for the rest of the project work. It will offer an introduction to biodiversity finance, introducing key concepts, providing definitions, as well as summarising challenges/issues related to financing biodiversity-focused nature-based solutions.
2. The literature review is also the starting point for the **sustainable financing inventory**, which will take the form of a database describing practical biodiversity financing options, key characteristics, strengths and weaknesses, and examples, and references. We will focus on ponds and pondscapes, though conclusions will also transferable to the financing of other types of nature-based solutions.
3. In addition, PONDERFUL will organise an **expert workshop** with 10-15 sustainable finance experts with the aim of identifying best practice examples, common challenges, practical solutions, and open questions related to sustainable financing of ponds as NBS.

4. An **inventory report** will bring together the conclusions from the literature review and inventory, as well as insights from the expert workshop. It will present best practice approaches, real-world examples, and recommendations serving as a basis for exploring collaborative financing options with local stakeholders and protocol development for the sustainable financing of small biodiversity projects and NBS.

Practical development of sustainable financing plans for pondscapes

1. In parallel, Ecologic will work together with three selected DEMO sites to explore and test the sustainable financing of pondscapes in practice. As a first step, Ecologic Institute and the selected DEMO sites will draw up a **template and protocol** for assessing sustainable finance needs and options of ponscapes.
2. This template will be completed by all DEMO sites with the support of Ecologic Institute. It will serve as input for the **stakeholder workshops** in the three selected DEMO sites, during which Ecologic will host sessions on sustainable finance accompanying the development of **sustainable financing plans.**

Based on the data and experience gathered in the application of the sustainable financing protocol in the DEMO sites and participation in workshops, as well as the literature review and expert workshop, Ecologic Institute will draft a **synthesis report** with insights on sustainable financing of pondscape NBS. It will contain lessons on sustainable financing of pond NBS for CC mitigation and adaptation, and biodiversity conservation for policymakers and practitioners, and other local stakeholders.

3.5 Assessing the socio-economic benefits of ponds (Task 1.6)

To answer the research questions in Task 1.6 the work will be organized into two sub-tasks, which will be carried out in chronological harmony with other tasks of the projects.

In the first sub-task, the multi-criteria decision analysis (MCDA) methodology will be applied to measure the relative importance among different criteria (e.g. environmental vs social criterion, environmental vs economic criterion…) and the relative importance of sub-criteria within each criterion (e.g. within environmental criterion, how relatively important carbon sequestration compared to biodiversity conservation or to flood risk mitigation...). This methodological framework will be implanted as in RPA (2004) within 4 steps:

Step 1 - Screening: Selection of primary and secondary criteria (indicators) for assessment.
Step 2 - Scoring: Get the relative importance of indicators based on pairwise comparisons using a 1 to 9 scale.
Step 3 - Weighting: Relative weights within the primary and secondary indicators groups for each stakeholder are derived.
Step 4 - Ranking: Rank the ponds and pondscapes according to the stakeholders' perceptions identified previously.

The data of this sub-task will be collected during the first workshop to elicit the preferences of local stakeholders regarding the relative importance of primary and secondary indicators. This methodological framework has been implemented successfully in other nature-based solution approaches such as in Alves et al. (2018) for selection of green/grey infrastructure to reduce flood risk and sequester carbon, or in Ruangpang et al. (2020) for planning large-scale water bodies such as river basins. There has not been conducted so far any research into small water bodies like ponds or pondscapes using this framework. Therefore, Task 1.6 aims to fill this research gap within the scope of PONDERFUL project.

With MCDA not producing outcomes, but rather used as a decision-support tool (IPBES, 2016), it will be important to provide a final benchmark ranking among pondscapes as well as between pondscapes and other nature-based solutions. For that reason, the second sub-task of Task 1.6 will provide an assessment of pondscapes relative to the "best practice" reference acting as a benchmark. This sub-task will use data gathered by other tasks of the project such as social survey data (Task 1.3), financing plan (Task 1.5), biodiversity data (Task 2.1), GHG emission data (Task 2.2), DEMO-Pondscape characterization (Task 4.3) etc. and similar data from other NBS projects to establish a best practice NBS frontier. This efficiency of pondscapes will be analyzed under a Data Envelopment Analysis

(DEA) methodology framework in combination with stakeholders' perceptions that will be collected as part of MCDA methodology from the first sub-task.

The benefits of pondscapes to the community and local inhabitants are unquestionable, and the findings of the other tasks listed above would provide conclusive evidence. With the DEA methodology, this sub-task aims to take a further step into investigating how pondscape can be economically efficient in achieving those desirable environmental and socio-economic benefits and compare the economic performance of one pondscape to another considering the local policy context and stakeholders' perceptions. This sub-task will also expand the scope to explore how efficient pondscapes could be in terms of providing ecosystem services and contributions to people.

4. Concluding remarks

In this Deliverable we outline why WP 1 works with the different dimensions of pondscapes that go beyond the ecology, and we present how exactly the work within particular tasks will be conducted.

By assessing the different social, economic, policy and financing aspects of pondscapes, the work within WP1 will provide results that will support broader application of pondscapes NBS, this contributing to the overall objective of PONDERFUL.

The assessment procedures presented in this Deliverable are subject to change, as they will develop throughout the project. This is because we are undertaking novel work concerning pondscapes that has to date not been done and there is a need to test how to best approach our research questions.

5. References

Alves, A., et al. (2018). Multi-criteria Approach for selection of green and grey infrastructure to reduce flood risk and increase co-benefits. European Water Resources Association (EWRA), 2505-2522.

Angelsen, A. (2009). Realising REDD+: National Strategy and Policy Options. CIFOR: Denmark.

Bastien, N.R.P., et al. (2012). Valuing amenity: public perceptions of sustainable drainage systems ponds. Water and Environment Journal 26, 19-29.

Biggs, J., et al. (2017). The importance of small waterbodies for biodiversity and ecosystem services: implications for policy makers. Hydrobiologia 793, 3-39.

Biggs, J., et al. (2019). Complementarity among dragonflies across a pondscape in a rural landscape mosaic. Insect Conservation and Diversity 12(3), 241-250.

Blayac, T, et al. (2014). Perceptions of the services provided by pond fish farming in Lorraine (France). Ecological Economics 108, 115-123.

Boothby, J. (1997). Pond conservation: towards a delineation of pondscape. Aquatic Conservation: Marine Freshwater Ecosystem 7, 127-132.

Cardinale, B.J., et al. (2012). Biodiversity loss and its impact on humanity. Nature 486, 59-67.

Castro, A.J., et al. (2014). Ecosystem service trade-offs from supply to social demand: A landscape-scale spatial analysis. Landscape Urban Planning 132, 102-110.

Christie, M., et al. (2019). Understanding the diversity of values of "Nature's contributions to people": insights from the IPBES Assessment of Europe and Central Asia. Sustainability Science 14, 1267-1282.

Daily, G.C. (Ed) (1997). Nature's Services: Societal Dependence on Natural Ecosystems. Island Press, Washington DC.

Davies, B.R., et al. (2008). Comparative biodiversity of aquatic habitats in the European agricultural landscape. Agriculture, Ecosystems & Environment 125, 1-8.

Deacon, C., et al. (2018). Artificial reservoirs complement natural ponds to improve pondscape resilience in conservation corridors in a biodiversity hotspot. PLOS One 13(9), e0204148.

Department for International Development. (2011) DFID's Approach to Value for Money (VfM), https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/67479/DFID-approach-value-money.pdf, accessed 28 June 2021.

Diaz, S., et al. (2018). Assessing nature's contributions to people. Science 359 (6373), 270-272.

Downing, J.A., et al. (2006). The global abundance and size distribution of lakes, ponds, and impoundments. Limnology and Oceanography Methods 51, 2388-2397.

Dumitru, A., Wendling, L. (2021). Evaluating the impact of nature-based solutions: a handbook for practitioners, European Commission EC, 373p.

EC. (2021). European Commission, The EU and nature-based solutions. https://ec.europa.eu/info/research-and-innovation/research-area/environment/nature-based-solutions_en

EPCN. (2008). The Pond Manifesto. European Pond Conservation Network.

Faivre, N., et al. (2017) Nature-based solutions in the EU: innovating with nature to address social, economic and environmental challenges. Environmental Research 159, 509-518.

Gozlan, R.E., et al. (2019). Status, trends, and future dynamics of freshwater ecosystems in Europe and Central Asia. Inland Waters 9, 78-94.

Harrison, P.A., et al. (2014). Linkages between biodiversity attributes and ecosystem services: a systematic review. Ecosystem Services 9, 191-203.

IPBES. (2016). *Preliminary guide regarding diverse conceptualization of multiple values of nature and its benefits, including biodiversity and ecosystem functions and services.* Kuala Lumpur: United Nations.

IPBES. (2019). Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. E. S. Brondizio, J. Settele, S. Díaz, and H. T. Ngo (editors). IPBES secretariat, Bonn, Germany.

Jarvie, J., et al. (2017). Valuing Multiple Benefits, and the Public Perception of SUDS ponds. Water 9, 128.

Kabisch, N., et al. (2016). Nature-based solutions to climate change mitigation and adaptation in urban areas: perspectives on indicators, knowledge gaps, barriers, and opportunities for action. Ecology and Society 21, 39.

Levin, S., et al. (2013). Social-ecological systems as complex adaptive systems: modeling and policy implications. Environment and Development Economics 18, 111-132.

López-Rodríguez, M., et al. (2015). Science-policy interface approach for dealing with water environmental problems. Environmental Science and Policy 50, 1-14.

Loreau, M., et al. (2003). Biodiversity as spatial insurance in heterogeneous landscapes. PNAS 100, 12765-12770.

Martín-López, et al. (2019). Nature's contributions to people in mountains: A review. PLoS ONE, 14(6).

Mathé, S., Rey-Valette, H. (2015). Local knowledge of pond fish-farming ecosystem services: management implications of stakeholders' perceptions in three different contexts (Brazil, France and Indonesia). Sustainability 7, 7644-7666.

Merilä, J., Hendry, A.P. (2014). Climate change, adaptation, and phenotypic plasticity: the problem and the evidence. Evolutionary Applications 7, 1-14.

Naumann, S, Davis, M. 2020. Biodiversity and Nature-Based Solutions: Analysis of EU Funded Projects. European Commission, Directorate General for Research and Innovation. https://data.europa.eu/doi/10.2777/183298.

OECD. (2012) Value for money and international development: Deconstructing myths to promote a more constructive discussion. In: Jackson, P. (ed.). Organisation for Economic Co-operation and Development, http://www.oecd.org/development/effectiveness/49652541.pdf, accessed 22 September 2016.

Pascual, U., Balvanera, P., Díaz, S., Pataki, G., Roth, E., Stenseke, M. et al. 2017. Valuing nature's contributions to people: the IPBES approach. Current Opinion in Environmental Sustainability, 26-27, 7-16.

Peterson, G.D., et al. (2018). Welcoming different perspectives in IPBES: "Nature's contributions to people" and "Ecosystem services". Ecology and Society 23(1), 39.

Pires, A.P.F, et al. (2020). Ecosystem services or nature's contributions? Reasons behind different interpretations in Latin America. Ecosystem Services. 42.

Quintas-Soriano, C., et al. (2018). Social-Ecological Systems influence ecosystem service perception: a Programme on Ecosystem Change and Society (PECS) Analysis. Ecology and Society 23(3).

Reed, M.S. (2008). Stakeholder participation for environmental management: A literature review. Biological Conservation 141, 2417-2431.

RPA. (2004). Evaluating a Multi-Criteria Analysis (MCA) methodology for application to flood management and coastal defence appraisals. London: Risk and Policy Analysts Ltd, Department for Environment, Food and Rural Affaris.

Ruangpan, L., et al. (2020). Incorporating stakeholders' preferences into a multi-criteria framework for planning large-scale Nature-Based Solutions. Ambio.

Seddon, N. et al. (2020). Understanding the value and limits of nature-based solutions to climate change and other global challenges. Philosophical Transactions of the Royal Society B 375, 20190120.

Science for Environment Policy. 2021 The solution is in nature. Future Brief 24. Brief produced for the European Commission DG Environment. Bristol: Science Communication Unit, UWE Bristol.

UNDP. (2018). BIOFIN Workbook 2018. United Nations Development Program. https://www.biodiversityfinance.net/sites/default/files/content/publications/BIOFIN%20Workbook%202018_0.pdf

Watkins, G., et al. (2019). Nature-Based Solutions: increasing private sector uptake for climate-resilience infrastructure in Latin America and the Caribbean Climate Change Division. Idb-Dp-00724: 16.

Williams, P., et al. (2004). Comparative biodiversity of rivers, streams, ditches and ponds in an agricultural landscape in Southern England. Biological Conservation 115, 329-341.

Williams, P., et al. (2020). Nature based measures increase freshwater biodiversity in agricultural catchments. Biological Conservation 244, 108515.

Yachi, S., Loreau, M. (1999). Biodiversity and ecosystem productivity in a fluctuating environment: The insurance hypothesis. PNAS 96, 1463-1468.

European Commission. (2021). Evaluating the impact of nature-based solutions: A handbook for practitioners. Dumitru, A. (ed.) & Wendling, L. (ed.), 4 May 2021, European Commission EC. 373 p.

Hinrichs-Krapels, S., Grant, J. (2016) Exploring the effectiveness, efficiency and equity (3e's) of research and research impact assessment. Palgrave Commun 2, 16090.

Stern, N.H. (2007) The Economics of Climate Change: The Stern Review. Cambridge University press: Cambridge.

6. Annex 1

Templates providing structured input to the assessment framework from Tasks 1.3 to 1.6 in WP 1

Task 1.3

Work package 1, Task 1.3	
Name	Joël Robin+ Jacques-Aristide Perrin = ISARA
Date	2021-04-02
Outline of the assessment	
In your words, what is the overall objective of WP1?	The WP1 furthers our understanding of the policy framework, of the geographical and social context and the economic conditions by valuing the ideas, opinions and possibilities of the inhabitants and the stakeholders.
What is/are the **research question**/s guiding your task? Which question(s) will your assessment answer?	How far does the study of social perceptions and NCPs's perception of many European pondscapes inform our understanding of the possible changes in practices and expectations in the framework of adaptation to the effects of climate change?
How does your assessment contribute to the **overall objective of WP1**?	Thanks to our data analysis, we will establish a typology of society's perceptions of pondscapes. Using this typology, we will identify the variability of benefits provided by pondscapes and NCP priorities. Our study could firstly provide an intermediate step toward defining priority of NBS' implementation and valuing the role of pondscape for both the quality of life and ecological transition. The survey will also gather information

	for the socio-economic analysis conducted in Task 1.6 Secondly, the survey findings will provide the foundation for choosing some relevant indicators to adapt NBS and pondscape management to the local social context. We find it quite helpful for improved development, implementation and management pond NBS.
Which **methodology** will you use to answer your question(s)? (If possible, provide an overview of alternative methodologies and an explanation of why you didn't select them.)	Applying an inter-site analysis method, data will be collected through quantitative and qualitative research tools. We are going to develop and circulate an inhabitant and stakeholders' questionnaires with an opportunity to describe their perceptions and knowledge about the ponderscapes of the 8 DEMOSites. For specific questions on NCP and NBS, we will use categories proposed by Diaz, 2018, IPBES, 2019 and Taskforces. We will organize 8 workshops with the participation of the stakeholders to discuss the results of their answers and about opportunities and threats for the future and priorities for improved management. For the organization, we think that face-to-face workshops have to be maintained if possible, because we think that virtual meeting could cause a lack a data compilation (due to a lack of interactions). The only other hypothetical possibility would have been to interact directly with every stakeholder thanks to some interviews conducted. The tight deadline of the task 1.3 that has now been set makes it impossible. A short term report based will provide information

	to Ponderful partners: specific aspects on each Pondscape, first comparative analysis between pondscapes. All data collected will be statistically analysed to propose a final draft on social perception and one or two papers to be submitted for publication.
Which **data** will you collect? How?	Respondent profile (gender, age, type of job, background) Social and geographical closeness (regularity and frequency of on-the-spot visits, distance from the home of visitors) Relation to nature (activities) Relation to the ponds (activities) Global knowledge (origin, change over the time, emblematic species) General assessment about the pondscape (aesthetic scenery, environmental state, idealistic characteristics of a pondscape, main risks) Perception of NCPs (role of the pondscape as a source of well-being) Perception of NBSs (choices to limit risks, measures to implement)
Which **output** will your assessment deliver?	Dissemination of statistical results of both questionnaires Account of each workshop Short term analysis on the social specificities of each pondscape The quantitative and qualitative results will be analysed and synthesised in a final report on social aspects and perceptions of pondscapes.

Where and how do you consider **gender** in your work?	We will pay special attention to the gender equity. If we may not be able to control the gender of the respondents of the resident's questionnaire, we can highlight the differences between the male and female perceptions of pondscapes. So, we will us a sex-disaggregated data. In the instances where we see a too big disparity of gender in the number of answers, we can weigh the data. Regarding the composition and functioning of the forthcoming workshops, we will strive for maximum of transparency and allocate speaking time about this issue. It should be noted that we aren't in direct contact with every stakeholder of every DEMOSite. This is the role of the DEMOSite leaders thanks to their knowledge in the field and the use of the vernacular languages. Yet, we will make sure they recruit participants, taking account of the gender equity.
What are the **linkages** of your task with **other sub-tasks and work packages**?	<u>Sub-tasks 1.3:</u> There's a real continuity in the collection of data between the both questionnaire and the implementation of the workshops. We look forward to discussing the results of the questionnaires during the workshop. This will give a good understanding and description of the differences between the gender, the inhabitants and stakeholders, the ranking of NCP's… <u>Task 1.3 in WP1:</u> Our task helps to complement the general understanding by valuing the ideas, opinions and

	possibilities of the inhabitants and the stakeholders.

Specific steps of the assessment	
Social Perceptions	Duration: M4-M32
	Responsibility of task lead: design collection strategy and a research protocol to success the survey in the DEMO-sites
	Responsibility of DEMO-site: making contact with stakeholders, circulate the WebLink of the questionnaire and publish the WebLink in passing through the websites of the local authorities (municipalities, districts?) and the managers of the water catchment + pass through the website of the research lab of each DEMOSite + hanging a poster/installing a information board on each pondscape+ social networks and WebBlog (schools, scholarly local associations, local libraries)
	Objective/ Output: 300-500 survey answers from a representative sample
Creation of resident survey	Duration: 3 months (March-May 21)
	Responsibility of task lead: redaction and improvement
	Responsibility of DEMO-site: translation, selection of websites to use for dissemination of questionnaire, agreement for using these websites, drop the questionnaire link on websites
	Objective/ Output: online questionnaires in June
Creation of stakeholder survey	Duration: 3 months (March-May 21)
	Responsibility of task lead: redaction and improvement, first step

	of translation
	Responsibility of DEMO-site: improved translation, dissemination of questionnaire to stakeholders participating to workshop 1
	Objective/ Output: questionnaires sent to stakeholders in June 21
Data collection stakeholder survey	Duration: 4 to 5 month according to workshop planning (June-September/October 21)
	Responsibility of task lead: data collection and recording
	Responsibility of DEMO-site: send questionnaire link to stakeholders, and re-send if needed (if no response of stakeholder)
	Objective/ Output: First data analysis for conducting stakeholder focus-group during workshop 1
Data collection during workshop 1	Duration: 4 months (August-November 21)
	Responsibility of task lead: facilitator of workshops
	Responsibility of DEMO-site: invite the participants, practical arrangements of the workshops (room, food service…), co-animation of focus groups (language !)
	Objective/ Output: consensual approach on social perception of pondscape and opinion about NCP assessment and NBS implementation. First report for DEMO-site leaders and project partners
Data collection resident survey	Duration: 9 months (June 21-February 22)
	Responsibility of task lead: data collection and recording, deploying other ways of data collection if needed
	Responsibility of DEMO-site: reviving the dynamics if the number

	of answers is weak (Kpi : 500 responses 300 minimum)
	Objective/ Output: first data analysis for DEMO site leaders and project partners
Data analysis	Duration: 9 months (November 2021-July 2022)
	Responsibility of WP-lead: data analysis
	Responsibility of DEMO-site: selection of data for further analysis
	Objective/ Output: proposition of first draft structure for publication
Drafting of synthesis report	Duration: 6 months (September 2022 - February 2023)
	Responsibility of WP-lead: writing
	Responsibility of DEMO-site: improving the text
	Objective/ Output: final report for deliverable Task 1.3 (Month 32). Final draft for publication

Task 1.4

Work package 1, Task 1.4	
Name	Malgorzata Blicharska
Date	2021-04-26
Outline of the assessment	
In your words, what is the overall objective of WP1?	The objective of WP1 is to help understand how we can remove social, policy, economic and financing barriers to facilitate broader implementation of pond NBS. By identifying these barriers we can also give recommendations on

	what could be done about them. The ultimate aim is to promote more pond NBS in the future.
What is/are the **research question**/s guiding your task? Which question(s) will your assessment answer?	1. What are policy factors (including policy processes and instruments, as well as existing data) at EU level that may hinder or facilitate implementation of pond NBS? 2. What are policy factors (including policy instruments) at local, regional and national levels that may hinder or facilitate implementation of pond NBS?
How does your assessment contribute to the **overall objective of WP1**?	We will identify policy drivers, barriers, and supporting instruments for implementation of pond NBS and by this we can show: - what needs to be changed in policies (approaches, instruments, data gaps, etc.) to better enable implementation of ponds NBS - what there already is in policies (processes, data, instruments, etc.) that can support implementation of ponds NBS – that one can build on to facilitate broader uptake of ponds NBS - the above two points: both at EU and local to national levels - this all will contribute to overall aim of promoting more ponds NBS
Which **methodology** will you use to answer your question(s)? (If possible, provide an overview of alternative methodologies and an explanation of why you didn't select them.)	Data will be gathered using: - Desk study of policy documents - Academic and grey literature review - Interviews with stakeholders - Stakeholder workshops (in DEMOsites) To analyse the data we will use qualitative

	content analysis. Alternatives would be surveys sent out to stakeholders, focus groups during workshops (potential, can be used anyway), Delphi study (but may be difficult to identify experts, and also, again, survey may be less good for gathering in-depth information)
Which **data** will you collect? How?	- Stakeholder mapping results - Basic information about socio-economic context of each DEMO-site in form of short text *- List of relevant policy documents at EU level in a template (will be collected by WP1, no help from DEMO-sites needed)* - List of relevant policy documents at DEMO-site level (local to national may be relevant), provided in a template with information about e.g. policy sector, type of policy, issuing authority, legally binding or not, main focus, what does it impact *-Results of the analysis of policy documents at EU level (will be analysed by WP1, no help from DEMO-sites needed)* - Results of the analysis of policy documents for DEMO-sites, in a template (relevant NCPs; impacts, drivers and responses mentioned/addressed – that can be relevant, e.g. impact ponds and pondscapes; instruments/incentives that could support or hinder implementation of ponds/pondscapes) - Results of interviews, in form of short narrative: Perceived barriers to pond creation and/or management (in relation to impacts, drivers, responses, instruments/incentives, etc. revealed in document analysis) - Results of stakeholder workshops in a template,

	e.g. scoring of some policy options defined during the interviews and document analysis
Which **output** will your assessment deliver?	Deliverable 1.3: Synthesis report on policy context of ponds and pondscapes Scientific papers: One paper on EU policy inventory, with focus on EU level barriers and opportunities for supporting pond NBS One or two (or more?) papers on DEMO-sites policy analysis, i.e. barriers and opportunities for supporting pond NBS (one paper could be on synthesis form all DEMO-sites, while other/s could be on some specific DEMO-site/country) Popular sciences article or press articles in known newspapers synthesising barriers and opportunities for supporting pond NBS
Where and how do you consider **gender** in your work? 1. Do you use sex-disaggregated data in your research? 2. Beyond that, do you consider gender elsewhere in your work? 3. Would you be interested in analyzing gender specifics out of the results of your Task?	During the interviews, gender will be noted. Also, if we use any surveys, there will be question on gender. Then this data can be used for gender specific analysis. We will also try to invite people of different gender to stakeholder workshops (as much as possible)
What are the **linkages** of your task with **other sub-tasks and work packages**?	This work is strongly related to Task. 1.5. on sustainable financing, as financing can be part of policies. There are also links to WP4, as part of the work will be done in DEMO-sites.

Specific steps of the assessment	
Step 1: Stakeholder mapping	Duration: January-April 2021
	Responsibility of Task-lead: Providing instructions and templates to fill in to DEMO-sites
	Responsibility of DEMO-site: filling in templates with information about stakeholders
	Objective/ Output: Synthesis (done by UU) of stakeholder mapping as input to Milestone 5
Step 2: EU policy inventory desk study data gathering and analysis	Duration: September 2021-January 2022
	Responsibility of Task-lead: data gathering and analysis
	Responsibility of DEMO-site: none
	Objective/ Output: - Overview of relevant policies (in a specific template) - Cross-cutting policy analysis to understand EU policy drivers, barriers, and supporting instruments for implementation of pond NBS Ultimate outputs: input to Deliverable 1.3 and draft of a scientific paper
Step 3: Mapping socio-economic context	Duration: November-December 2021
	Responsibility of Task-lead: providing instructions of what is needed
	Responsibility of DEMO-site: writing short text about socio-economic context of the DEMO-site (basic info about the pondscape; e.g. main land covers, origin of pondscape, land ownership, important sectors at play, population, key issues of

	interest in relation to ponds, e.g. which NCP are important, what are problems and challenges in this area, etc.)
	Objective/ Output: Short text (1-2 pages) from each DEMO-site
Step 4 Mapping policy space	Duration: November-December 2021
	Responsibility of Task-lead: Preparing instructions, including clear examples, as well as a template to fill in
	Responsibility of DEMO-site: Preparing a list of policies and some data about them filled in in the template (e.g. policy sector, type of policy, issuing authority, legally binding or not, main focus, what does it impact, etc.);
	Objective/ Output: List of policies in the template
Step 5: Analysis of policy documents at DEMO-sites	Duration: November 2021-February 2022
	Responsibility of Task-lead: Providing detailed instructions for policy analysis, including clear examples, as well as templates to fill in with data (e.g. relevant NCPs; impacts, drivers and responses mentioned/addressed - that can be relevant, e.g. impact ponds and pondscapes; instruments/incentives that could support or hinder implementation of ponds/pondscapes). *Potentially UU can help with analysis of documents in languages that we know (not sure yet which, besides English, as it depends on my future PhD student and what languages he/she will speak)*
	Responsibility of DEMO-site: conducting policy analysis and filling in the template
	Objective/ Output: template filled in with data
Step 6: Policy interviews with	Duration: February 2022-June 2022
	Responsibility of Task-lead: Creation of an interview guide, quite

stakeholders on perceived barriers to pond creation and/or management (based on the policy documents analysis)	structured, so it is easy to get responses that could be summarised in a simple template/form
	Responsibility of DEMO-site: Conducting 5-10 interviews with key stakeholders and filling in template with data. Alternatively, data could be collected through a group work on workshops in DEMO-sites.
	Objective/ Output: Template filled in with data
Step 7: Stakeholder workshop 2: discussing results of desk study and interviews	Duration: August 2022 to January 2023
	Responsibility of Task-lead: Clear and detailed instructions for organising policy session on the second workshop; training and individual discussions with DEMO-sites before the workshop. Preparing template to fill in with data (e.g. scoring of some options by stakeholders as important realistic, etc.)
	Responsibility of DEMO-site: Organising the workshop and filling in the template
	Objective/ Output: Template filled in with data
Step 8: Synthesis	Duration: February-June 2023
	Responsibility of Task-lead: Synthesis and writing report
	Responsibility of DEMO-site: reading and reviewing final deliverable report (May 2023)
	Objective/ Output: Deliverable 1.3 June 2023

Task 1.5

Work package 1, Task 1.5 Sustainable finance	
Name	Isabel Seeger, Manuel Lago, Hugh McDonald (Ecologic Institute)

Date	15 April 2021
Outline of the assessment	
In your words, what is the overall objective of WP1?	The aim of WP1 is to understand social, economic, financial, and political barriers to the widespread implementation of pondscapes as NBS, and identify opportunities for effectively, efficiently, equitably increasing pondscape implementation.
What is/are the **research question**/s guiding your task? Which question(s) will your assessment answer?	What are existing and potential financing options for pondscape NBS (both public and private)? What are their strengths and weaknesses? What barriers limit financing of pondscape NBS?
How does your assessment contribute to the **overall objective of WP1**?	A lack of finance is a barrier to the implementation of ponds as NBS. In T1.5 we will identify financing options for pondscape NBS and support the development of sustainable financing plans for the NBS in the DEMOsites. In addition, we will provide general insights and identify barriers and opportunities related to sustainable financing of pond NBS, supporting the widespread implementation of pondscapes as NBS beyond PONDERFUL.
Which **methodology** will you use to answer your question(s)? (If possible, provide an overview of alternative methodologies and an explanation of why you didn't select them.)	- Literature review (grey and academic literature) - Stakeholder workshops - Expert workshop - Expert interviews - Co-development of sustainable financing plans
Which **data** will you collect? How?	Data on the financing situation of all DEMO-sites (using the sustainable finance template that we will develop)
Which **output** will your assessment deliver?	- An inventory of sustainable financing options for ponds NBS

	- Sustainable finance plans for three chosen DEMO-sites - Final report identifying barriers related to financing pondscape as NBS and opportunities for finance to support their widespread implementation - Academic paper and/or policy brief (optional) - based on final report
Where and how do you consider **gender** in your work? 1. Do you use sex-disaggregated data in your research? 2. Beyond that, do you consider gender elsewhere in your work? 3. Would you be interested in analyzing gender specifics out of the results of your Task?	1. We will not be using sex-disaggregated data (as we will be working with DEMOsites as a whole, rather than individuals). 2. We will strive for gender balance in our expert workshop and expert and stakeholder interviews. 3. We would be interested in discussing how we could analyse gender specifics (and other intersectional elements e.g. class, race, etc.) in our work.
What are the **linkages** of your task with **other sub-tasks and work packages**?	Task 1.4 (Policy) will provide top-down analysis of public finance options for pond NBS Task 4.3 (Economic evaluation of DEMOsites) - will provide data on costs and benefits generated by pond DEMOsites (for sustainable finance templates)

Specific steps of the assessment	
Literature review: overview of biodiversity finance (1.5.1)	Duration: 11 months (M3-M13)
	Responsibility of task-lead: Conduct literature review and draft overview section
	Responsibility of DEMO-site: none
	Objective/ Output: An introduction to biodiversity finance covering definitions as well as key challenges/issues related to financing biodiversity-focused nature-based solutions, based on

	a review of grey and academic literature.
Literature review: sustainable finance inventory (1.5.1)	Duration: 12months (M3-M15)
	Responsibility of task-lead: Conduct literature review and create inventory and report
	Responsibility of DEMO-site: Selected DEMOsites will be asked to provide feedback on inventory format
	Objective/ Output: A database describing practical biodiversity financing options, key characteristics, strengths and weaknesses, examples, references based on a review of grey and academic literature. The target audience will be developers of small biodiversity projects (e.g. pond DEMOsite leads), will also be used to support DEMO-site leads in T1.5.2. An inventory report of sustainable financing options for small biodiversity protection/ NBS bringing together the conclusions from the literature review and inventory, as well as insights from the expert workshop. It will present best practice approaches, real-world examples, and recommendations serving as a basis for exploring collaborative financing options with local stakeholders and protocol development.
Literature review: identify experts (1.5.1)	Duration: 11 months (M5-M11)
	Responsibility of task-lead: Conduct literature review create a list of experts
	Responsibility of DEMO-site: none
	Objective/ Output: A list of potential invitees for the expert workshop
Sustainable finance expert workshop (1.5.1)	Duration: 2 months (M9-12)
	Responsibility of task-lead: Ecologic will organize an expert workshop on biodiversity financing featuring 10-15 experts. This includes: - Selection and invitation of participants (finance experts, local and regional government representatives, and NGO representatives) - Plan and implement workshop

	- Background note before workshop and workshop report following workshop
	Responsibility of DEMO-site: Selected DEMOsite leads may be invited to participate
	Objective/ Output: The workshop is an opportunity to identify best practice examples, common challenges, practical solutions, and open questions related to sustainable financing of ponds as NBS. The specific focus is yet to be determined.
Draft paper/ policy brief based on expert workshop (OPTIONAL) (1.5.1)	Duration: M12-M16
	Responsibility of task-lead: The results of the expert workshop could be used to draft a paper or a policy brief (optional). Ecologic would lead the drafting and publication process.
	Responsibility of DEMO-site: none
	Objective/ Output: scientific paper and/or policy brief
Develop sustainable finance template & protocol for DEMO-sites (1.5.2)	Duration: 28 months (M10-M36)
	Responsibility of task-lead: Develop the template & protocol
	Responsibility of DEMO-site: Three selected DEMO-sites contribute to the development of the template and protocol (by providing feedback and completing it)
	Objective/ Output: A sustainable financing plan protocol and template for all DEMOsites.
Implement sustainable finance template & protocol (1.5.2)	Duration: M24-M36
	Responsibility oftask-lead: Offer support (help desk) for DEMO-sites
	Responsibility of DEMO-site: Complete templates
	Objective/ Output: Completed templates from all DEMOsites
Sustainable finance workshop 1 (3 DEMO-sites) (1.5.2)	Duration: 7 months (M9-15)
	Responsibility of task-lead: In three DEMOsites, lead Sustainable Finance Session One - Scoping. Preparation: Provide feedback to DEMOsite lead re. invites (to suggest local finance experts); preparation of content. On the day: Introductory presentation (motivating why financing

	is important, very brief intro to sustainable financing options). Session activities: World-café to brainstorm different short/long-term objectives (financing needs, social/environmental/other objectives), resources (i.e. voluntary/paid employees, existing funding options), challenges/barriers. Prioritise brainstorming results (stickers on whiteboard), and sum up objectives for financing. After: Workshop session report.
	Responsibility of DEMO-site: Organise workshop (invites, orga etc.) DEMOsite stakeholders will have to participate in the workshop session (1 hour).
	Objective/ Output: For DEMOsite participants: motivate financing, convince why it is important and an exciting opportunity For WP1: Identify local DEMOsite finance objectives, opportunities, challenges, and test/refine our sustainable finance template and guidance.
Sustainable finance workshop 2 (3 DEMO-sites) (1.5.2)	Duration: 7 months (M21-27)
	Responsibility of task-lead: In the same three DEMOsites, lead Sustainable Finance Session Two - Co-creation of options/selection of optimal financing options. Preparation: Draft economic evaluation of DEMOsite (task 4.3) to identify financing needs and finance gap. On the day: Introductory presentation (present economic costs through presentation of finance; present potential financing options (from inventory). Session activities: Identify gaps/problems in economic evaluation. Small group work to co-develop different financing options, and identify responsible stakeholders to progress financing plan. Identify barriers to financing. After: Workshop session report and co-creation of sustainable

	finance plan with DEMOsite participants.
	Responsibility of DEMO-site: Selected DEMOsite participants to participate in preparatory interviews. Participate in workshop.
	Objective/ Output: Workshop orga. For DEMOsites: Sustainable finance plan draft For WP1: Co-create draft sustainable finance plan, identify barriers and opportunities.
Sustainable finance workshop 3 (3 DEMO-sites) (1.5.2)	Duration: 6 months (M32-38)
	Responsibility of task-lead: In the same three DEMOsites, lead Sustainable Finance Session Three – Finalising sustainable finance plan Preparation: Support DEMOsite participants and DEMOsite lead to co-develop finance plan. On the day: Introductory presentation (w/ DEMOsite participants) (presenting proposed sustainable finance plan). Session activities: Identify gaps/problems in sustainable finance plan (world-café on specific sections). Small group work to identify next steps and responsibilities. Reflect on experience: Identify barriers, tips – vote on whiteboard. After: Workshop session report.
	Responsibility of DEMO-site: Workshop orga. Preparation: DEMOsite lead and selected participants to continue to develop sustainable finance plan (i.e. complete template) Participate in workshop.
	Objective/ Output: For DEMOsites: Sustainable finance plan for three selected DEMO-sites For WP1: Co-created draft sustainable finance plan (evidence for task 1.5), reflections on challenges, barriers, opportunities.

Synthesis report (1.5.3)	Duration: 6 months (M32-38)
	Responsibility of task-lead: Drafting report to synthesise insights on sustainable financing of pond NBS. Based on the data and experience gathered in the application of sustainable financing protocol in the DEMO sites and participation in workshops, we will synthesise the lessons on sustainable financing of pond NBS for CC mitigation and adaptation, and biodiversity conservation for policymakers and practitioners, and local stakeholders.
	Responsibility of DEMO-site: Selected DEMOsites may be asked to review and comment on final report.
	Objective/ Output: Synthesis report on sustainable financing of the establishment of ponds and pondscapes, identifying barriers and opportunities to increase effectiveness, efficiency, and equity of financing pond NBS

Task 1.6

Work package 1, Task 1.6	
Name	Socio-Economic Analysis
Date	Answer
Outline of the assessment	
In your words, what is the overall objective of WP1?	To establish a framework to assess the implementation of pondscapes as NBS in a holistic way, including policy, social aspects, socio-economic analysis and sustainable financing, with the involvement of stakeholders through the implementation of workshops.
What is/are the **research question**/s guiding your task? Which question(s) will your assessment	1. How can we quantify the socio-economic benefits of pondscapes? 2. How can stakeholders perceive the relative

answer?	importance of criteria (environmental, social, economic etc.) and sub-criteria of ponds as NCP? Based on this perception, how pondscapes are ranked? 3. How efficient are pondscapes, in comparison with each other as well as with other NBS projects?
How does your assessment contribute to the **overall objective of WP1**?	Support the effective and efficient implementation of pondscapes from a socio-economic perspective.
Which **methodology** will you use to answer your question(s)? (If possible, provide an overview of alternative methodologies and an explanation of why you didn't select them.)	1. Multi-criteria decision analysis • Analytic Hierarchy Process (pairwise comparison) • Multi-Attribute Value Tree (in case there are too many criteria to compare pairwise) 2. Data Envelopment Analysis
Which **data** will you collect? How?	1. Weights of criteria - by surveying the stakeholders - primary data. 2. Economic criteria values - primary data. 3. Value of environmental criteria from WP2 (no additional value - only standard data from those tasks). 4. Cost-benefit analysis data from Task 1.5. 5. Social-cultural analysis data from Task 1.3. 6. Scenarios for dynamic analysis - Task 3.2, 3.3, 3.5. 7. Data from other NBS projects.
Which **output** will your assessment	1. Relative importance of different socio-economic

deliver?	and environmental criteria associated with pondscapes as NBS, in the form of weights deducted from the survey. 2. Ranking of pondscapes in terms of environmental and socio-economic performances and efficiency.
Where and how do you consider **gender** in your work? 1. Do you use sex-disaggregated data in your research? 2. Beyond that, do you consider gender elsewhere in your work? 3. Would you be interested in analyzing gender specifics out of the results of your Task?	Difference in weights between genders, might lead to different result of ranking pondscapes and best practices. 1. The sex-disaggregated data is collected via stakeholder's workshop, for AHP method specifically. 2. n/a 3. Yes. But how? Can you give a specific example?
What are the **linkages** of your task with **other sub-tasks and work packages**?	Please check the data part above.

Specific steps of the assessment	
Step 1: MCDA Survey Design	Duration: M5 - M8
	Responsibility of task lead: Select socio-economic and environmental indicators, design survey
	Responsibility of DEMO-site: Translate into related language
	Objective/ Output: Survey
Step 2: Collect data from 1st stakeholders'	Duration: M9 - M15
	Responsibility of task lead: Design collection activities and

workshops	support DEMO-sites during data collection period
	Responsibility of DEMO-site: Conduct the workshops
	Objective/ Output: Data for MCDA analysis
Step 3: Analyze the data and deduct the weights.	Duration: M16 - M18
	Responsibility of task lead: Conduct Analysis
	Responsibility of DEMO-site: -
	Objective/ Output: Relative importance of criteria
Step 4: Design efficiency analysis and collect data from other NBS projects	Duration: M19 - M24
	Responsibility of task lead: Design DEA models and collect data
	Responsibility of DEMO-site: -
	Objective/ Output: DEA models to analyze the efficiency of pondscape
Step 5: Efficiency analysis	Duration: W25 - W31
	Responsibility of task lead: Analysis
	Responsibility of DEMO-site:
	Objective/ Output: Benchmarking and best practices of pondscapes as NBS
Step 6: Finalization	Duration: W31 - W37
	Objective/ Output: Draft a synthesis report that includes the results of all analysis and frameworks for socio-economic assessment within Task 1.6.

7. Annex 2

PONDERFUL Concept Note (Milestone 5)

Ponderful

Pond Ecosystems for Resilient Future Landscapes in a Changing Climate

Milestone 5

THE PONDERFUL CONCEPT NOTE

This project has received funding from the European Union's Horizon 2020 research and Innovation programme under the grant agreement No 869296

WP No	1	**Start Date**	Month 1
WP Title	Stakeholder involvement, policy, society, and sustainable financing	**Document Title**	The PONDERFUL Concept Note
WP Lead	Malgorzata Blicharska, UU	**Version**	1

Title	:	The PONDERFUL Concept Note
Delivered by	:	Malgorzata Blicharska, UU
Nature	:	Internal report
Planned Submission	:	30th April 2021
Actual Submission	:	23th April 2021

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Table of Contents

Executive Summary

The Concept Note includes a consolidated glossary with key terms and concepts relevant for PONDERFUL's work, as well as results of the stakeholder mapping. The aim of the glossary is to enhance standardisation across participants and countries in the project and across different disciplines. Both the glossary and the results of stakeholder mapping were discussed during specific sessions during the Kick-off meeting on the 2nd of February 2021, and the discussions helped to refine initial ideas and develop the final Concept Note.

Introduction

PONDERFUL project

The PONDERFUL project focuses on the role of ponds, and their congregations, i.e. pondscapes (networks of ponds) in the delivery of different Ecosystem Services (ES) and Nature's Contributions to People (NCPs). Particular attention is paid to pondscapes' role in climate mitigation and adaptation, as well as in biodiversity conservation.

Ponds are, both globally and in Europe, the most numerous freshwaters, collectively dominating both water area (30-50% of standing water worldwide (Downing et al. 2006, Biggs et al. 2017) and contributions to aquatic biodiversity (e.g. supporting 70% of the freshwater species pool in European landscapes (Williams et al. 2004, Davies et al. 2008)).

In spite of their great ecological importance, ponds are largely neglected in water- and nature-related national and EU policies and strategies (Biggs et al. 2017). This is problematic, as ponds are exposed to the same threats as larger bodies of water (e.g. land and water use, pollution, invasive species) and may be particularly vulnerable to climate change, being less buffered to temperature extremes and changes in hydrology. That impacts both their number and state (e.g. changes in hydro-period, water level, salinization and eutrophication) (Gozlan et al. 2019). As biodiversity value and Ecosystem Services (ES)/Nature's Contributions to People (NCP) delivery is likely to dramatically change with the ecological status of ponds, there are important impacts to consider.

PONDERFUL will quantify the relations between biodiversity, ecosystem state, ES/NCP and climate change (CC), develop scenarios for climate mitigation and adaptation using pondscapes, and test the implemented pondscape-based solutions using demonstration sites (DEMO sites) co-developed with stakeholders. Ultimately, PONDERFUL will develop practical tools for creating and managing pondscape Nature-Based Solutions (NBS).

The mission of the PONDERFUL project is to increase the understanding of the role of ponds and pondscapes in providing NCPs/ES and to promote

greater implementation of ponds as NBS in order to mitigate and adapt to the current trends of environmental deterioration.

The main objectives of PONDERFUL are thus to:

1. Develop a multidimensional framework to support the effective implementation of pondscape NBS for CC mitigation and adaptation, biodiversity conservation and ES/NCP delivery, based on empirical investigation of existing governance context of ponds and their economic viability, and collaboration with stakeholders
2. Understand how biodiversity, ecosystem state and processes, and ES/NCP co-vary and interact in pondscapes across a climatic gradient
3. Use empirical data, incorporating direct and indirect interactions and feedbacks between CC, land use, biodiversity, ES/NCP and connectivity, to develop a modelling framework predicting the impact of CC on biodiversity and ES/NCP of ponds for various land use and pondscape scenarios
4. Develop efficient and effective NBS for CC adaptation and mitigation through pondscape management as well as tools and guidance for their implementation
5. Communicate, disseminate and exploit project's results

PONDERFUL applies an inter- and trans-disciplinary approach which combines different fields (social and political sciences, gender studies, environmental economics, ecology, biodiversity studies, experimental ecology, community ecology, landscape ecology and pond conservation, restoration and management) and methods (e.g. ecological surveys, scenario development, modelling, policy analysis, testing of pondscape-oriented NBS, etc.).

We use demonstration sites (so called "DEMO-sites") in eight countries across Europe and Uruguay for analysing the policy context and social perception of ponds, quantifying the biodiversity, ecosystem state and ES/NCP, developing scenarios for climate mitigation and adaptation using pondscapes, and testing the implemented NBS. We are collaborating with the EC's Nature Based

Solutions (NBS) Task Forces (https://networknature.eu/) to contribute to their work of promoting NBS in Europe and beyond.

The Concept Note

PONDERFUL's approach involves researchers from a wide range of disciplines. As such, standardisation of terminology and concepts used, as well as development of a common understanding of key issues relevant for the project is crucial. Thus, the Concept Note serves the PONDERFUL project with information about the terminology applied and concepts used in the project, with a particular focus on harmonising the activities of Work Package 1. It represents Milestone 5 of PONDERFUL and is one of the project's KPIs.

The Concept Note includes a consolidated glossary with key terms and concepts relevant for PONDERFUL's work, as well as results of the stakeholder mapping. The aim of the glossary is to enhance standardisation across participants and countries in the project and across different disciplines. Both the glossary and the results of stakeholder mapping were discussed during specific sessions during the Kick-off meeting on the 2nd of February 2021, and the discussions helped to refine initial ideas and develop the final Concept Note. This glossary does not aim to be definitive but rather to serve as a first common input to enable interdisciplinary cooperation based on a shared vocabulary. Definitions may be adapted at a later stage in the project and new entries may be added.

Conceptual basis for the PONDERFUL project

This section provides an overview of the most important concepts used in the PONDERFUL project and situates the project in a broader scientific context. It introduces the main focus and aims of the PONDERFUL project and relates it to the ongoing environmental changes and challenges we are facing. In addition, this section presents why ponds and pondscapes are important, what benefits they provide and how they can contribute to addressing environmental challenges. It also describes the decision-making processes relevant for ponds and pondscapes and a general policy context in which the decisions are taken.

Ponds and pondscapes are presented as socio-ecological systems which can be used as Nature-based Solutions in order to address environmental challenges.

The context of the project – why PONDERFUL?

We are currently facing many global challenges, key ones being biodiversity decline and climate change, both having important consequences for humans (IPBES 2019a). Biodiversity decline, driven by increasing human population, land use change, habitat fragmentation and climate change, continues, even if numerous policies, initiatives and projects have been implemented during the last decades to counteract this trend (Cardinale et al. 2012). This is worrying, because functioning ecosystems based on rich biodiversity are a prerequisite for human survival and well-being (Daily 1997, Harrison et al. 2014), as biodiversity contributes to the delivery of numerous ES or NCP. Climate change aggravates biodiversity decline, as it puts pressure on ecosystems through increases in extreme weather events such as floods, droughts and storms, desertification of some areas, as well as changes in average temperatures and precipitation. It also leads to an increase in new pests and invasive species and novel contexts of community interactions. This forces species to adapt or migrate, which not all are equally capable of (Merilä and Hendry 2014). All of these factors, in turn, have impacts on human well-being, e.g. in terms of food security, heat stress, zoonotic diseases or potential conflicts). At the same time, more resilient ecosystems, i.e. ecosystems that can withstand different disturbances, have the potential to mitigate the effects of climate change and to help us adapt to its consequences (Loreau et al. 2003; Yachi and Loreau 1999).

The IPBES[1] concluded that biodiversity decline is 'unprecedented' and species extinction rates are 'accelerating'. At the same time, the recent assessment of

[1] The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) was established in 2012 to strengthen the scientific evidence base for developing policy on biodiversity conservation (https://www.ipbes.net/). It published a set of assessments in 2018-2019, reviewing past and current trends and synthesising projections of future trends for the state of the natural

the Intergovernmental Panel on Climate Change (IPCC), published in 2019, highlighted the escalating costs and risks of delaying action against climate change and its consequences and suggested that choices we are making now are critical for our future.

In relation to the above, ponds and pondscapes are crucial. They provide important habitats for rich biodiversity, which is a prerequisite for delivery of many benefits, particularly in the face of climate change, e.g. flood mitigation, carbon storage or water provision.

DPSIR: Driver-Pressure-State-Impact-Response

To understand and address the changes in pondscapes, PONDERFUL will follow the DPSIR (Driver-Pressure-State-Impact-Response) approach, which is a framework developed by the European Environmental Agency (EEA 1995, Fernandez et al. 2014) to identify links between drivers, pressures and ecosystem state, as well as their impacts and related responses. DPSIR identifies the relationships between:

- drivers (underlying causes/needs; e.g., economic growth, urbanisation, rising energy demand),
- pressures (human activities resulting from the needs; e.g., use/abuse of resources, emissions, and land-use change),
- state (effect on the biological, physical, and chemical state, of the environment),
- impacts (on ecosystem functions and public health),
- and responses (policies addressing DPSI) (Gupta et al. 2020).

The DPSIR framework provides a structure for the investigation of how pressures can lead to changes in ecosystem state and impacts on human

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environment (including biodiversity), NCP and ES, as well as general human well-being.

wellbeing.[2] The DPSIR approach formalises the relationships between various sectors of human activity and the environment as chains of links.

In line with this approach, PONDERFUL will use the information on existing drivers and pressures on pondscapes, as well as policy, economic and social context contributing to them, together with an analysis of the current state of biodiversity, ES/NCPs and their interactions in existing pondscapes. This allows us to (i) estimate the impact of and contribution to climate change, (ii) propose adequate responses in the form of tailor-made policy approaches, management approaches and financing instruments, (iii) assess the potential of pondscapes as NBS to mitigate and adapt to climate change, and (iv) promote and implement these NBS for ecological and societal well-being.

Modelling and scenarios

Scenarios and models can play an important role in decision making by alerting decision makers to undesirable future impacts of the direct drivers of biodiversity loss such as land use change, invasive alien species, overexploitation, climate change or pollution. They can also provide decision support for developing management strategies and assist in exploring the implications of alternative social development pathways and policy options. From a scientific perspective, scenarios and models also help to better understand and synthesize a broad range of observations (IPBES 2016).

Scenarios describe possible futures for drivers of change or policy interventions, and models translate those scenarios into projected consequences for nature and NCP/ES (IPBES 2016). For example, scenarios may describe plausible future trajectories of human population growth, economic growth, agricultural productivity or greenhouse gas emissions, and they may also consider specific policy interventions such as increasing protected area coverage or implementing policies to eliminate harmful subsidies. Within PONDERFUL we will explore positive scenarios, inspired in

[2] For example, economic growth (driver) leads to waste disposal (pressure) that results in the deterioration of the chemical or ecological state of freshwater bodies (state). The negative consequences on ecosystems and human health (impact) could lead to better waste water management (response), paving the way for ecological recovery.

the Nature Futures Framework of IPBES, with the implementation of NBS management actions (see a hypothetical example in Fig 1). These scenarios for socio-economic development and policies can then be translated into the direct drivers of biodiversity loss such as climate change. Biodiversity models typically quantify how habitats or species are impacted by these drivers. Ecosystem services models typically quantify how provisioning services, such as food or timber production, and regulating services, such as carbon storage or water purification by ecosystems, are affected by these drivers.

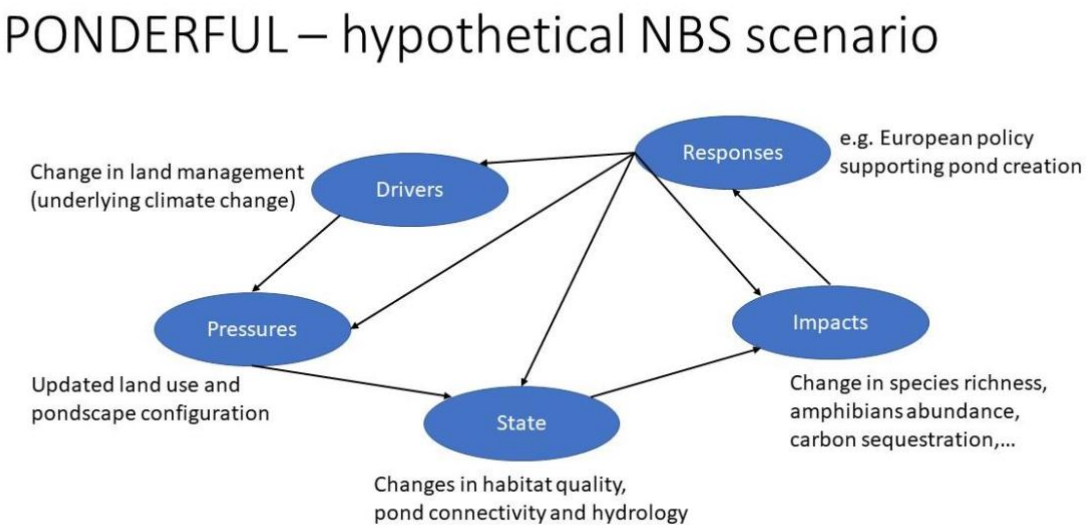


Figure 1. Hypothetical NBS scenario.

Projections of biodiversity and ES change, based on different scenarios, are produced in three steps (Pereira, Leadley et al., 2010), broadly described here as:

1. Storyline development - a narrative of a plausible future co-developed with stakeholders (i.e. stakeholder preferences for improved management of pondscapes), exploring different NBS (informed by WP4) such as creation of new ponds, widening existing ponds, improving vegetation surrounding ponds, etc. The different strategies will be discussed in the stakeholders' workshops (WP1);

2. Projections of drivers – models translate these narratives into estimates of change in land use, i.e. they 'update' the pondscape (WP3); and
3. Impacts – a different set of models is then used to estimate impacts on biodiversity (e.g. species richness, abundance) and ecosystem services (e.g. flood regulation, carbon sequestration) of such change in land use, and under different climate change trajectories.

These impact models will be integrated in WP3 into a comprehensive modelling framework. As a result, we will have estimates of changes in a variety of biodiversity and ES indicators/criteria, which will be used together in a multicriteria decision tool (WP4). Using this decision-making support tool stakeholders can visualise the impact of the different scenarios and have an estimate of the costs and benefits of the different NBS implementations.

The unprecedented rate at which natural resources are being depleted was put in the spotlight by the IPBES Global Assessment (2019a). Such results highlight the need to develop strategies to move beyond the status quo towards a trajectory of sustainable development. Developing positive scenarios, inspired by different NBS, and informed by the large number of studies showing that biodiversity underpins many ecosystem processes and services, and ultimately our well-being (Isbell, Adler et al., 2017), can be key to help visualize ways to reach these more positive end points.

Importance of ponds for biodiversity

In the face of ongoing land use and climate change, and resulting biodiversity decline, pond ecosystems have a special role to play. While individual ponds may seem not that important when compared to larger water bodies, such as lakes or streams, collectively they represent 30 % of the global freshwater area (EPCN 2008).

Ponds and pondscapes are crucial for biodiversity conservation, in fact supporting a larger proportion of rare, endemic and threatened freshwater species than lakes or rivers (Williams et al. 2004). They are also key elements of blue landscape connectivity, acting as stepping stones between freshwater water habitats (Davies et al. 2008). Networks of ponds support the metapopulations of many aquatic species, such as invertebrates, amphibians

and aquatic plants, and are thus important in supporting regional biodiversity. In addition, ponds support rare species of semi-aquatic margins, a few of many examples being beavers, clam shrimps, great crested newts (*Triturus cristatus*), natterjack toads (*Bufo calamita*), agile frogs (*Rana dalmatina*), fire-bellied toads (*Bombina bombina*), and a range of rare dragonflies and damselflies (e.g. pygmy damselfly (*Nehalennia speciosa*) and island darter (*Sympetrum nigrifemur*) (EPCN 2008).

Ponds may also have the potential to play an important, but poorly quantified, role in climate regulation, as they have the potential to sequester large amounts of carbon in their sediments (Taylor et al. 2019), while they can also be sources of greenhouse gases (GHG) (CO2, CH4 and N2O) (Holgerson et al. 2016). The few reported measurements of GHG dynamics in ponds suggest that warming may reduce the sequestration potential of ponds, potentially even leading them to emit carbon, but how biodiversity and ecological status of ponds (e.g. domination of either macrophyte or phytoplankton) interact with temperature to affect these emissions and other ES is not well understood. There is also insufficient knowledge on how ponds and their biota respond to climate change, how this translates into effects on ecosystem processes and ES, how local scale processes interact with regional landscape scale processes, and how this feeds back to our capacity to mitigate and adapt to climate change (Davidson et al. 2018).

Ecosystem functions, Ecosystem Services and Nature's Contributions to People

The importance of ponds and pondscapes reaches beyond their direct function as a habitat for biodiversity, but includes carbon storage, water provision, flood control, freshwater recharge, pollution amelioration and recreation, which all matter to human well-being in different ways.

What benefits people can get from ecosystems, such as ponds, depends on the underlying biodiversity and ecosystem functions that are supplied. These are often conceptualised using a cascade model (Fig. 2), where biophysical structures or processes lead to ecosystem functions that in turn provide ecosystem services, which in turn offer humans benefits that have value to them (Potschin and Haines-Young 2016). For example, vegetation in a pondscape provides the function of slowing down water flow, which in turn

provides the services of flood control. This provides a benefit of security, which is valued by people.

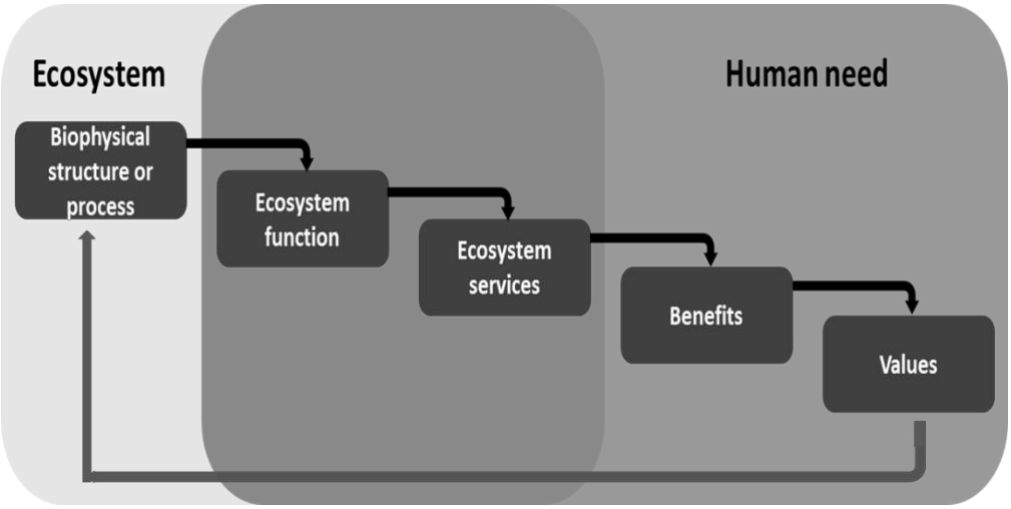


Figure 2. Ecosystem services cascade model, simplified after Potschin and Haines-Young 2016.

The cascade model incorporates the concept of Ecosystem Services (ES) that first appeared in 1981 (Ehrlich and Ehrlich 1981) and received increasing recognition after 2005 when the Millennium Ecosystem Assessment (MA 2005) was published, which highlighted the role of ecosystems for human survival and well-being.[3] The ES has been subject to different classifications. Most know is the classification by Millennium Ecosystem Assessment (MA 2005) that divides ES into four categories:

- Provisioning services - tangible ES that are directly used by people, e.g. food, wood, energy sources;

[3] Since then, there have been a substantial number of scientific publications on ES (Martinez-Harms & Balvanera 2012, Milcu et al. 2013, Blicharska et al. 2017) and conceptual advancements, such as the distinction between supply and demand of ecosystem services, that have laid theoretical foundations for a wide range of approaches to ES assessment (Burkhard et al. 2012, Liquete et al. 2013).

- Regulating services – the ways in which ecosystems regulate different environmental processes, e.g. water purification, flood control, noise reduction;
- Cultural services – intangible ES related to the cultural or spiritual needs of people, e.g. recreational or educational possibilities,
- Supporting services – ecosystem processes and functions that underpin the other three types of services, e.g. photosynthesis, soil formation.

There has been much debate about the fourth category, given that there is a risk that ecosystem features are counted twice as a provisioning/regulating/cultural service and as the support to these services. The newest classification of ES by Common International Classification of Ecosystem Services (CICES; Haines-Young and Potschin 2018), does not treat the last category of MA (supporting) as ecosystem services, but rather as functions of ecosystems underlying other categories of ES.

In 2017, IPBES introduced a new and closely related concept – Nature's Contributions to People (NCP). While the ideas behind NCP do not differ greatly from the ideas in the past ES research, the NCP framework formalizes some recent conceptual and methodological frontiers in ES research (Kadykalo et al. 2019). Also, the NCP concept builds on the ES research adding novel conceptualizations of people and nature relations and a more comprehensive view on these relations (Kadykalo et al. 2019). For example, the NCP concept relates to, respects, recognizes, and embraces diverse worldviews on human-nature relations and is associated with and can consider and incorporate relational values when linking NCP and wellbeing (Pascual et al. 2017, Díaz et al. 2015; Díaz et al. 2018). NCPs also represent a more inclusive language and framing. The NCP term has been well received and received mainstream attention, and is seen as more palatable, understandable, and neutral by some (Kadykalo et al. 2019). It also allow to incorporate biodiversity directly as a NCP, e.g. through NCP18 (Maintenance of Option Value).

Key NCPs assessed within PONDERFUL are:

- creation and maintenance of habitats for biodiversity,

- pollination,
- regulation of hazards and extreme events (flood control),
- regulation of freshwater quantity, location and timing,
- regulation of water quality,
- regulation of climate (e.g. carbon storage),
- physical and psychological experiences (e.g. recreation, tourism),
- learning and inspiration.

In the PONDERFUL project we use the classification of NCPs as introduced by IPBES, but acknowledge and build on the broader research on ES.[4] . Throughout, rather than aiming for methodological purity, we take advantage of both ES and NCP methodologies; and aim for the consolidation of concepts in relation to the management of ponds. Our overarching aim is to take advantage of both approaches to develop evidence that will support improved understanding of the many benefits delivered by pondscapes (including climate mitigation, adaptation, biodiversity protection, as well as cultural and intrinsic value) and to support improved evidence-based decision making. We want to build a framework as widely applicable as possible.

Nature-Based Solutions

Because of their role in supporting biodiversity and delivering crucial ES/NCPs to people, ponds can be seen as important Nature-Based Solutions (NBS) to climate change adaptation and mitigation. NBS are solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions increase diversity and amounts of nature and natural features and

[4] For example, some of the indicators that are used in assessing NCPs in the project's DEMO-sites are derived from ES initiatives, such as the works of the EC Working Group on Mapping and Assessment of Ecosystems and their Services (MAES), which falls under one of the specific actions for the implementation of the EC 2020 Biodiversity Strategy (ref xx)

processes in cities, landscapes and seascapes. They are locally adapted, resource-efficient and systemic interventions (EC 2021, Science for Environment Policy 2021).

Typology of NBS

A widely adopted typology was proposed by Eggermont et al. (2015). It divides the NBS into three broad types (under each type we list a few examples of NBS that are relevant to ponds):

Type 1 NBS - minimal or no intervention in ecosystems, with objectives related to maintaining or improving delivery of ecosystem services within and beyond the protected ecosystems, for example:

- Establishment of protected areas or conservation zones
- Limitation or prevention of specific land use and/or practices
- Ensuring of continuity of ecological networks (protection from fragmentation)
- Maintenance or enhancement of natural wetlands
- Controlling urban expansion
- Regular monitoring of physical, chemical or biological indicators

Type 2 NBS - extensive or intensive management approaches seeking to develop sustainable, multifunctional ecosystems and landscapes in order to improve delivery of ecosystem services relative to conventional interventions, for example:

- Spatial and/or time and frequency aspects of integrated and ecological management plans
- Creation and preservation of habitats and shelters to support biodiversity
- Ground water management
- Control water quality and erosion through management of grazing animal stocking density and exclusion of grazing animals from riparian areas
- Integrated water resource management

- Aquifer protection from pollution and sustainable management of withdrawals

Type 3 NBS - characterised by highly intensive ecosystem management or creation of new ecosystems. Type 3 NBS include, for example:

- Creation of Ponds
- Creation of retention ponds
- Creation of wetlands
- Restoration of degraded waterbodies
- Creation of riparian buffer zones
- Creation of floodplains or floodplain reconnection with rivers
- Slope revegetation

In PONDERFUL we will develop an inventory of different pond NBSs, including information on their specific role and effectiveness.

Pondscapes as socio-ecological systems and importance of scale

To use the results of modelling, scenarios and NCP assessment in a meaningful way, one needs to understand pondscapes as socio-ecological systems with relations and feedbacks that operate at multiple spatial scales. Ecological systems are complex and how they behave depends on many interactions between their different components. They are also continuously changing and adapting to changing conditions (Levin et al. 2013). At the same time, ecological systems are strongly interconnected with social, political and economic systems, as human activities and decisions impact the management and state of ecosystems. Thus, many different stakeholders are engaged in decision-making regarding ecosystems and impact ecosystems in various ways. This is of course also the case for ponds and pondscapes and thus to implement them on a larger scale and manage them in a way that promotes their benefits requires broad engagement of different actors. These actors operate at multiple spatial and governance scales and represent different sectors and areas of interest. They could be authorities and decision makers at levels from local to international (e.g. EU), NGOs, representatives of

academia and private actors as well as land owners and land owner organisations.

In PONDERFUL we will engage with a wide range of stakeholders (see section on stakeholder mapping), to gather information relevant for the social, policy and finance aspects of the project, discuss baseline scenarios and co-develop future positive scenarios, co-create resources to be used by practitioners and policy makers, and communicate and disseminate the project's results.

Because the ecological and social systems are intertwined, to manage and plan for the ecological systems it is important to understand the policy context in which they are embedded and learn about decision making processes that are involved (see next two sections).

In the assessment of biodiversity, ecosystem functions and services, and their interaction with society, it is important that spatial scale is taken explicitly into consideration. In addition to the local pond, whose condition can be improved by local management, the "pondscape", as the set of ponds in a given landscape, plays an important role. Connectivity of ponds in the landscape or region, amongst others determined by the density of the ponds, will affect local persistence of species populations, metacommunity structure and regional diversity. As such there is a strong potential for interaction between the local and regional level – with a higher density in high quality ponds supporting local biodiversity through enhanced connectivity and sources for species immigration, while regional diversity is supported by local habitat quality. Pondscapes can refer to specific sets of ponds in the landscape, or any area of interest – either defined by ecology (catchment area, floodplain, valley, etc.) or by societal or political borders (urban pondscape, provincial or national borders).

Policy context

Public policy is "what government chooses to do or not to do" to maintain social order and address the needs of citizens (Dye, 1972). Policies are thus choices that are results of governmental decisions. The decision makers can be found at many different governance levels, from local (e.g. municipality) to regional, national (e.g. nature conservation agency at national level) and

international. The policies can also take many forms, e.g. legal acts, ordinances, decrees, different types of strategies (at local, regional or national level), spatial plans, as well as guidelines and recommendations issued by different authorities. These can be both legally binding and non-binding documents.

One can discuss policy content (substantive perspective) and the process through which policies are made (procedural perspective). Content-wise, policies include policy goals (basic aims and expectations) and policy means (instruments to implement policy). *Policy goals* can be either general objectives (e.g. a vision for something) or very specific targets (e.g. % of something to be achieved). *Policy means* (instruments) can be of different types – they can be legal (e.g. some legal regulations), economic and financial (e.g. incentives in form of tax reduction), or informational (e.g. information campaign). The policy process is often referred to as a policy cycle, with five stages: agenda-setting (problem recognition), policy formulation (proposal for solution), decision-making (selection of solution), policy implementation (putting solution into effect), policy evaluation (monitoring results). The evaluation may lead to reconceptualization of problems and a start of a new policy cycle (Howlett 2011).

As ponds are largely neglected in policies, there is an urgent need to incorporate considerations for these small water bodies into key environmental and water-related policies (Hill et al. 2018). In recent years there has been an increasing recognition of the role of wetlands in EU policy making, which might also open up an avenue for discussing pondscapes. Besides passing specific environmental policies, emphasis has been extended to environmental policy integration. Environmental policy integration refers to the incorporation of environmental concerns in policy sectors outside of the traditional environmental policy domain, for example agriculture, urban planning or transport. It can overcome negative environmental outcomes resulting from the institutional specialization of sectoral policy, and make environmental policy more effective. In practice, however, implementation of environmental policy integration remains difficult and there is no clarity on 'what works, where and why?' (Runhaar et al. 2014, Persson and Runhaar 2018).

Providing scientific advice is one of the ways of influencing all five stages of the policy cycle and thus affect the implementation or improvement of existing policies, as well as the creation of new policies and policy integration across sectors. By providing expertise on the state and drivers of environmental change, as well as on the implications of a range of potential policy responses, scientists can support the policy process in reaching its objectives. They can also contribute to evaluation of existing policies, leading to new problem recognition that in turn can lead to new solutions.

The work conducted in PONDERFUL can help mainstreaming considerations for ponds and pondscapes in different decision-making processes. In addition, the policy inventory and local policy analysis will reveal existing facilitating factors, implementation barriers, and financing instruments for pond NBS implementation contributing to recommendations on what can be improved in the policy and decision-making processes.

The EU policy landscape governing pondscapes

Pondscapes are located within national jurisdictions, but EU policy nonetheless matters greatly to their conservation, restoration and creation. European pondscapes are highly diverse, including ponds located on agricultural lands, ponds that are part of protected areas, and artificial ponds in urban parks. As a result, there are a range of sectoral and cross-cutting EU policies and strategies relating to pondscapes and the various drivers, pressures, states, impacts and responses. The current legal framework as well as ongoing processes for its revision and extension, are described below.[5]

The current legal framework

The backbone and legal basis of current EU biodiversity protection are the so-called 'nature directives', which comprise the **Habitats Directive** (adopted in 1992) and the **Birds Directive** (adopted in 1979 and updated in 2010). The objective of the Habitats Directive is to conserve over 200 types of habitats

[5] In practice, EU policies are translated into and complemented by national and sub-national policies, which however will not be specifically considered here.

and more than 1000 plant and animal species, while the Birds Directive specifically targets wild birds and their habitats. Under the nature directives, the EU-wide Natura 2000 network of protected areas has been established, stretching over 18% of the EU's land area and more than 8% of its marine territory (EEA 2020). Member States have the responsibility to maintain or restore favorable conservation status for the listed habitats and species and must report monitoring results to the European Commission every six years. The habitats protected and monitored under nature directives include mires, bogs and fens, and different types of standing waters, as well as habitats of significance to wild birds - making the nature directives directly relevant to pondscapes across Europe.[6]

The foundation of European water management is the **Water Framework Directive** (WFD, adopted in 2000), which aims to achieve good chemical and ecological status for all inland surface waters, transitional and coastal waters and groundwater. The WFD does not apply to bodies of water smaller than 0.5 km^2, thereby excluding ponds from its realm. The directive is nonetheless relevant to pondscapes, because their state is impacted by the quality of adjacent surface and ground water bodies. Several specific directives, also relevant to pondscapes, complement the WFD: The **Groundwater Directive** (adopted in 2006) limits inputs of pollutants into groundwater, the **Nitrates Directive** (adopted in 1991) prevents nitrate pollution of both ground and surface waters and the **Urban Waste Water Directive** (adopted in 1991) controls the adverse environmental effects of waste water discharges. A further specific directive to the WFD is the **Floods Directive** (adopted in 2007) on the assessment and management of flood risks. It requires Member States to draw up national flood risk management plans, possibly including the maintenance and restoration of floodplains, promotion of sustainable land use practices and improvement of water retention capacities of the soil. Because pondscapes may play a role in these natural flood management strategies, the Directive could support their conservation, restoration and creation.

One of the sectoral policies most relevant to pondscapes is the **Common Agricultural Policy** (CAP), which accounts for more than a third of the total

[6] There is no data available on the total number of pondscapes incorporated into the Natura-2000 network.

EU budget. Agriculture generates multiple pressures on ponds, for example land use change and nitrogen pollution. While the CAP's objective to improve agricultural productivity thus sometimes run counter to environmental objectives, the CAP also aims to address climate change and sustainable management of natural resources and is a significant source of funding and incentives for pond conservation and creation. EU farmers receive income support based on their farm's size in hectares, which are linked to cross-compliance, requiring them to keep their land in good agricultural and environmental condition (GAEC). One of the conditions for reaching GAEC is the conservation of landscape features, including all ponds. Moreover, since the 2013 CAP reform 30% of direct payments must go to 'greening', meaning that they specifically reward more sustainable use of agricultural land: Besides crop diversification and maintenance of permanent grassland, farmers need to dedicate 5% of arable land to areas beneficial for biodiversity (ecological focus areas, EFA) to be eligible. Ponds generally qualify as EFAs, though the exact choice depends on Member States. In addition to direct payments, the CAP funds Rural Development Programmes (RDP) through the European Agricultural Fund for Rural Development (EAFRD). One of the objectives of these programmes is the preservation, restoration, and enhancement of ecosystems related to agriculture and forestry, including of farmland ponds.

The latest 7-year programming cycle of the CAP in 2020, but due to ongoing negotiations, most of the current rules were extended under a transition regulation until 2022. The EU ministers reached agreement on a general approach on the **post-2020 CAP reform** in October 2020, in which they agreed to increase environmental ambition. The agreement envisions instruments like novel mandatory eco-schemes to encourage and reward environment- and climate-friendly farming practices (e.g. agro-ecology, precision farming, carbon farming), as well as stricter environmental conditions for direct payments. There remains significant uncertainty about the future design and implementation of the CAP.

The future policy landscape

In December 2019, the European Commission presented the **European Green Deal** (EGD) to address climate and environmental challenges, which has set a

number of policy processes in motion. In addition to the reform of the Common Agricultural Policy, the outcomes of these processes may result in increased regulatory or financial support for pondscape conservation, restoration and creation:

- The **EU Biodiversity Strategy for 2030** (published in May 2020) outlines the Commission's plan to improve biodiversity. A key element is the commitment to protect 30% of land and sea in Europe, whereby one third of protected areas will be strictly protected.[7] The strategy also announced an **EU Restoration Strategy** with binding targets, as well as an **EU Soil Strategy** and an **EU Action Plan for zero pollution in air, water and soil,** which have yet to be published.
- The **EU Adaptation Strategy** (February 2021) has four principal objectives: To make adaptation smarter, swifter, more systemic and to step up international action. The strategy specifically addresses the importance of nature-based solutions, such as protecting and restoring wetland and peatlands, developing urban green spaces or sustainably managing forests and farmland.
- The **Farm to Fork Strategy** (published in May 2020) sets out to reduce the environmental and climate footprint of the EU food system and strengthen its resilience. To ensure that the food chain has a neutral or positive environmental impact, it suggests new green business models such as carbon farming, the reduction of chemical pesticides and fertilizers, as well as the promotion of organic agriculture. The annex of the strategy also announced an **Action Plan for the Development of Organic Production.**
- The proposal for a **European Climate Law** (initially proposed in March 2020, amended in September 2020) introduced a target of 55 % reduction of the EU's GHG emissions by 2030 as well as the objective for the EU to become climate-neutral by 2050. It is currently undergoing negotiations.

[7] Currently 18% of land area are Natura-2000 sites and national legislation protect an additional 8%, totaling 26% (EEA 2020).

- The Commission announced the intention to publish a **Renewed Sustainable Finance Strategy**. It will aim to create an enabling framework for sustainable investments by both the public and the private sector, including opportunities to mobilise finance for biodiversity protection. The **EU Sustainable Finance Taxonomy**, which is currently under development, will support the implementation of the strategy by establishing a list of environmentally sustainable economic activities.

It is important to note that these strategies are providing guidance and direction, but have yet to be translated into legally-binding legislation and concrete action. This complex policy-making process and the surrounding discussions offer opportunities to the PONDERFUL project to advance the conservation, restoration and creation of pondscapes as nature-based solutions to reach the objectives of the EGD.

Decision making in relation to ponds and pondscapes

In case of PONDERFUL, relevant stakeholders are groups of individuals that can affect or be affected by policy decisions that are relevant for ponds and pondscapes. Such decisions do not need to directly consider ponds or pondscapes as such, but could be e.g. decisions in different sectors that have impact on ponds and pondscapes, e.g. decisions in nature conservation sector, decisions concerning climate change, agricultural policy, spatial planning decisions, management decisions (e.g. about creation and/or maintenance of ponds). Relevant stakeholders include both public and private stakeholders.

There can be different types of decisions when it comes to ponds and pondscapes:

1. Decisions about pond creation: if to build/create a pond, what type of pond (and thus why to do it, what is the motivation), when to do it, where to locate it, how to do it and from what sources will it be financed

2. Management decisions: if to manage a pond (and which ponds in a pondscape to manage), and why, what kind of management could/should be conducted, how often, and who will finance that.

3. Decisions that could potentially prioritise other use of land than creation of pond/s, e.g. farmers filling in/draining ponds or spatial planning decisions promoting other land use,

4. Decisions that do not directly deal with ponds, but may impact them, i.e. land use and management impacting ponds, e.g. pig farms in Spain, urban areas in Turkey.

5. Decisions about financing NBS

A decision support tool will be produced in order to support decision-makers to compare different scenarios, considering a set of criteria. A scenario is a (regional) policy strategy supporting the protection and development of small aquatic ecosystems. Scenarios are distinguished by the targeted objectives (example: double or maintain the density of ponds?). The criteria allow the benefits and costs of different scenarios to be assessed (e.g. number of species, carbon storage, etc.) The decision-makers will also have the possibility to set some preference parameters, such as the weighting of the criteria, in order to take into account the social, economic and political context.

Sustainable financing of ponds NBS

Costs and effectiveness of NBSs are difficult to estimate or calculate ex-ante implementation. For example, the protection, restoration, and creation of ponds is costly. Upfront costs of restoring and creating ponds can include planning and design costs, the hire of diggers and drivers, land purchase, planting among others. Ongoing costs can include maintenance, management, and monitoring, as well as the cost of lost income that may have otherwise been earned from the land. These costs can be significant and, when combined with other costs such as the difficulty of behavior change, can pose significant barriers to the widespread implementation of ponds as nature-based solutions.

NBS uptake is currently very low. Technical, institutional, financial and policy barriers hinder their uptake. Indeed, a lack of finance has been identified as one of the main barriers to their implementation (Faivre et al, 2017). Ultimately, projects are unlikely to be developed and financers will rarely lend or invest without a clear business case and a clear proof of concept setting

out the costs, benefits, and risk profiles. The main challenge relates to calculating and capitalizing NBS's diverse benefits:

- NBS deliver benefits to multiple beneficiaries. Because the benefits to each beneficiary are small (relative to the sum of benefits - and to the costs), individual beneficiaries may not be motivated to finance ponds, even when they would deliver social net benefits (i.e. the sum of benefits outweighs the costs) (Seddon et al. 2020).
- Many of the NBS benefits (e.g. biodiversity protection) are not valued in traditional economic markets, making it challenging to monetize these benefits (Wild et al. 2017).
- NBS deliver benefits over long timescales, which can pose challenges for traditional, short-term sources of funding (Kabisch et al, 2016).

These challenges can make it difficult to accurately assess the expected costs and benefits of nature-based solutions. This is presently, discouraging investment from public and private financers when faced with this uncertainty. The lack of private investment leaves NBS implementation at the discretion of available public budgets. Naumann and Davis (2020) report that 75% of NBS so far have been funded by the public sector (Naumann and Davis 2020). But in addition, limits to public budgets condition upscale of nature-based solutions such as ponds. There is a need to move beyond the current model.

This has led to a research focus on biodiversity finance, with a view to increase knowledge to mobilise private investment in the protection of nature. BIOFIN, the UNDP's Global Biodiversity Financing Initiative, defines **biodiversity finance** as "*the practice of raising and managing capital and using financial and economic incentives to support sustainable biodiversity management*" (UNDP, 2018). While this broad definition takes the perspective of the national policy-maker, capturing all of the levers they have at their disposal to support the widespread protection of biodiversity (and implementation of NBS), within PONDERFUL, the sustainable finance work will take the perspective of the pond project developer (e.g. regional government, farmers, local NGOs, among

others)[8]. The aim will be to assess existing and potential funding and financing opportunities for the implementation of pond NBS, highlighting their relative strengths and weaknesses, and relative suitability for different pond project developers.

The financing measures considered will include:

- Grants – i.e. public or other non-commercial funding from governments or other funders;
- Debt/equity – i.e. loans or investment funding from banks or investors;
- Risk management – payments related to a transfer in risk, for example in collaboration with insurance companies or other affected beneficiaries;
- Market options – such as offset certificates or payment for ecosystem services;
- Other – other potential sources of funding, including collaborative community approaches or other coordination mechanisms.

Ultimately, the sustainable finance work within PONDERFUL is concerned with the question of how to ensure there is sufficient money available to create, maintain or restore pond NBS to protect biodiversity and deliver climate mitigation, adaptation, and other benefits. By identifying o pportunities and barriers, we will aim to help overcome the barrier of insufficient biodiversity financing for NBS, and support its most effective, efficient, and equitable distribution.

[8] Note: the policy makers perspective (and options for improved policy to deliver more effective, equitable, efficient, and widespread pond NBS) will be considered by PONDERFUL's policy task.

Stakeholder mapping

Stakeholder involvement is an important part of PONDERFUL work and it should start early on, to enable their meaningful contribution to the project. Mapping of stakeholders is an important first step in this process for all the DEMO-sites. The aim of the mapping is to gather basic information about key stakeholders, with particular focus on their roles, their interest in the project and their impact (power) in relation to ponds and pondscapes.

The exercise of stakeholder mapping is supposed to help DEMO-sites in planning, launching and organising the DEMO-site work, and particularly organisation of the three stakeholder workshops, together with WP1.

Between January and April 2021, two steps of stakeholder mapping were conducted in the DEMO-sites. In the first step, basic information about stakeholders was gathered, for example: their name, their type (public/private), gender, contact information, stakeholder's role, interest and impact (scored from 1=low to 3=high), as well as the level of collaboration in place (from advanced to not established yet). In the second step of the mapping the information on the more specific roles of stakeholders, as well as their priorities regarding particular NCPs (as perceived by the DEMO-site leaders). For the both steps, DEMO-site leaders were provided with mapping instructions (see Annex z and 1).

Below, we provide a short synthesis of the stakeholder information. The actual stakeholder data are available from DEMO-site leaders and WP1 on request (however, respecting ethical and privacy consideration, e.g. no names of particular people or contact information will be shared outside the PONDERFUL's consortium).

Number and type of stakeholder

In general, particular DEMO-sites provided information on from 7 to 65 stakeholders per DEMO-site, altogether 258 stakeholders, on average 29 stakeholders per DEMO-site. 140 stakeholders were identified as public, and 114 as private stakeholders (Fig. 3).

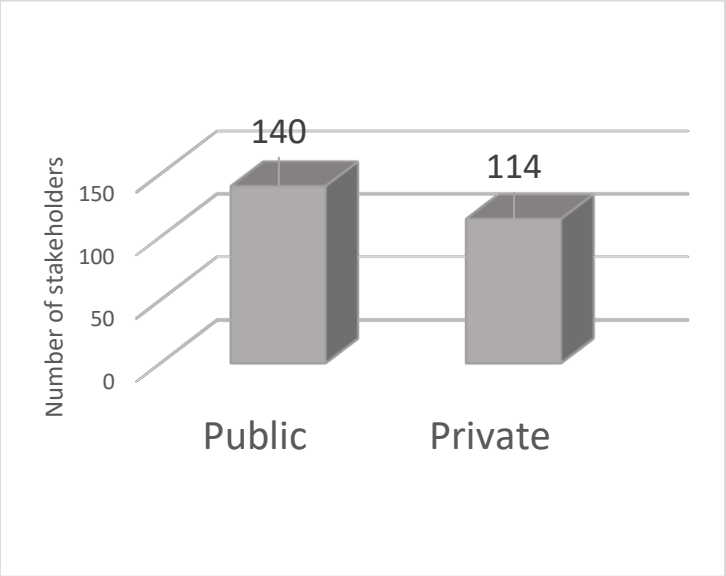


Figure 3. Type of stakeholder

Gender of stakeholders

While not for all stakeholders individual representatives were identifies, for the ones that they were, males prevailed (143 males, compared to 68 females) (Fig. 4).

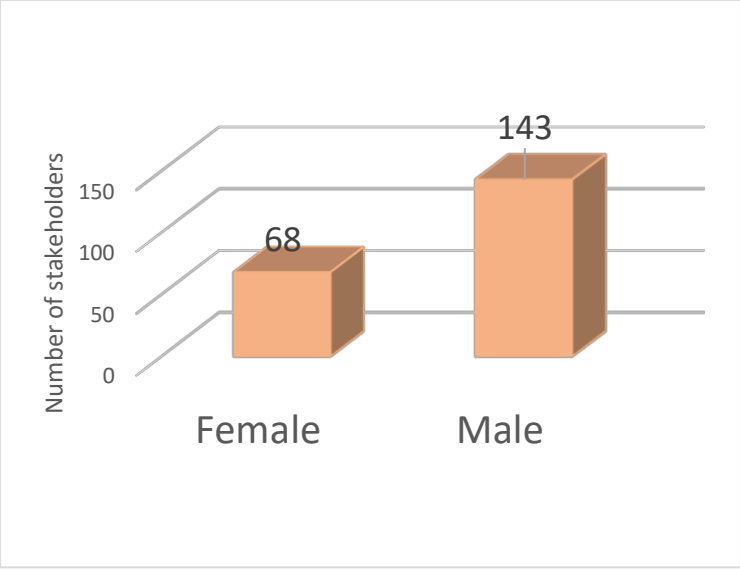


Figure 4. Gender of the stakeholders

Interest, impact and collaboration in place

For most of the stakeholders interest in the project and impact they had (as perceived by the DEMO-site leaders) was rather high, with scoring 2 and 3 prevailing (Fig.5 and 6).

The collaboration was in place with approximately 51 % of all identified stakeholders, either some (24 %) or advanced (27 %). The remaining stakeholders (49 %) still need to be contacted, and collaboration needs to be established (Fig. 7).

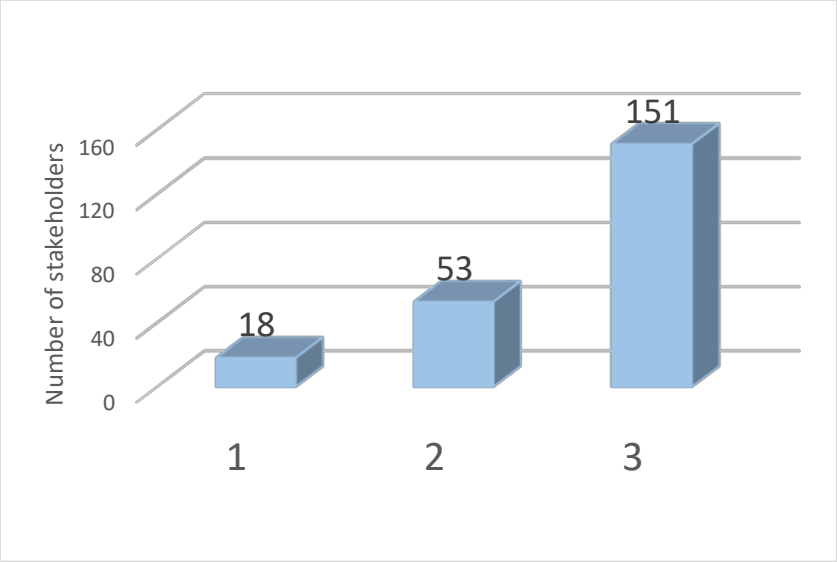


Figure 5. Interest level of stakeholders with regard to PONDERFUL project, where 1 = low and 3 = high.

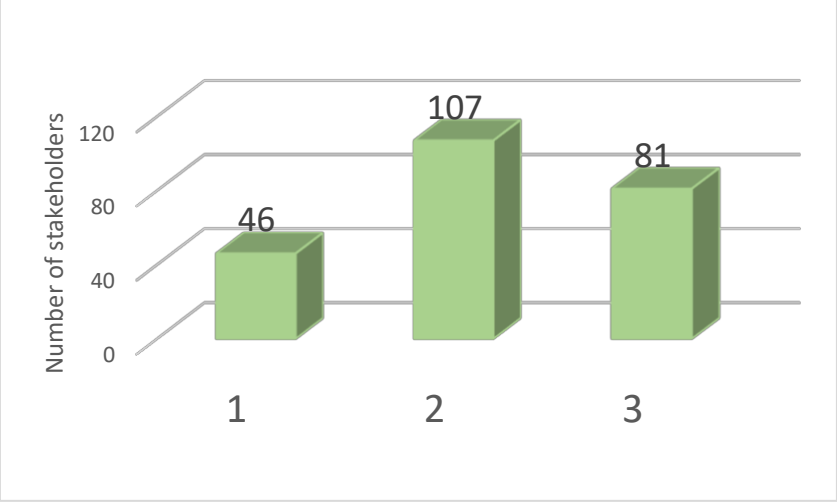


Figure 6. Impact level of stakeholders with regard to ponds and pondscapes, where 1 = low and 3 = high.

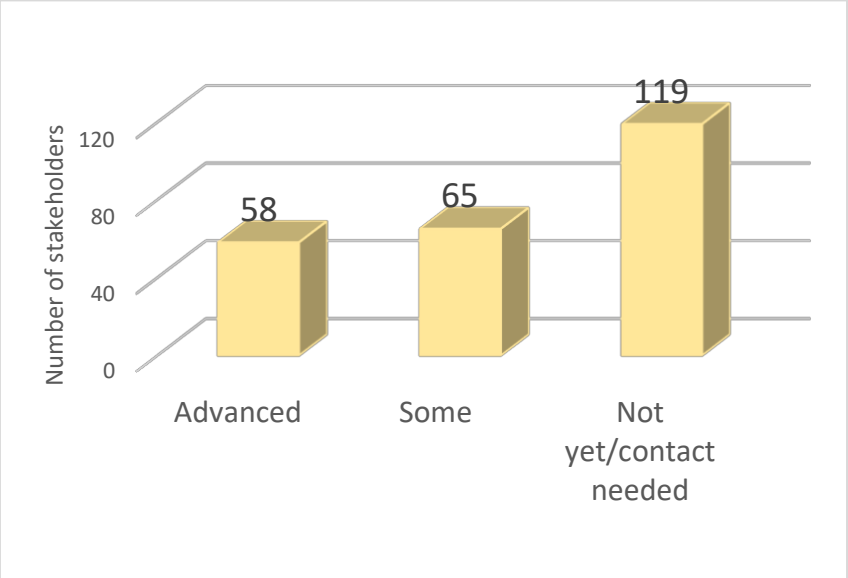


Figure 7. Level of collaboration in place with identified stakeholders.

Stakeholder roles

Most of the stakeholders could influence decision on what type of pond will be created, decision how to manage the pond, and decision if a pond will be created, while much less stakeholders could actually decide about these aspects of pondscapes and ponds (Fig. 8). Relatively many stakeholders could provide information inportant for pond creation or management, and could access the area.

Geographical scope of the stakeholders in relation to their remit/functions was in most cases national, followed by regional and local (Fig. 9).

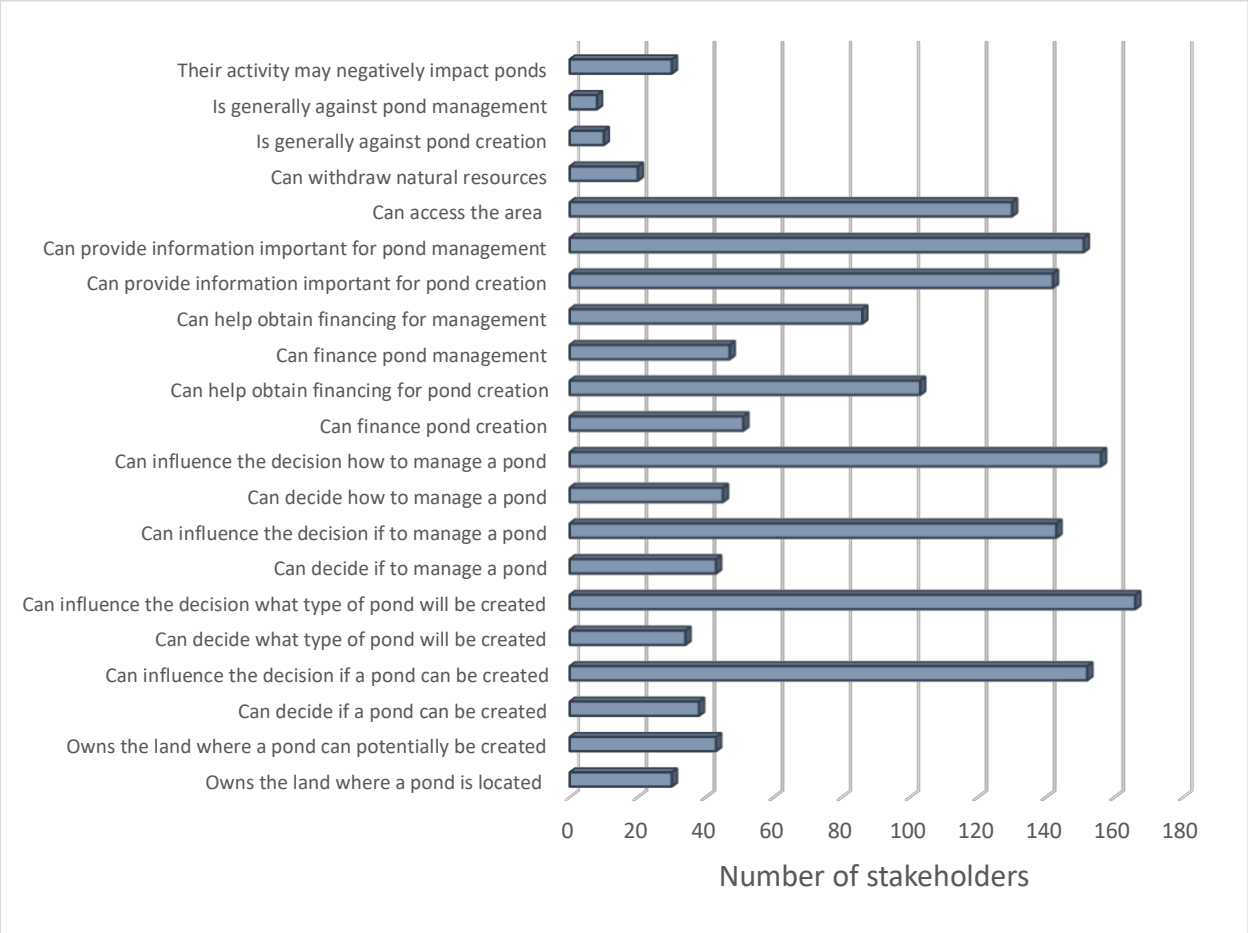


Figure 8. Summary of the key roles of the stakeholders

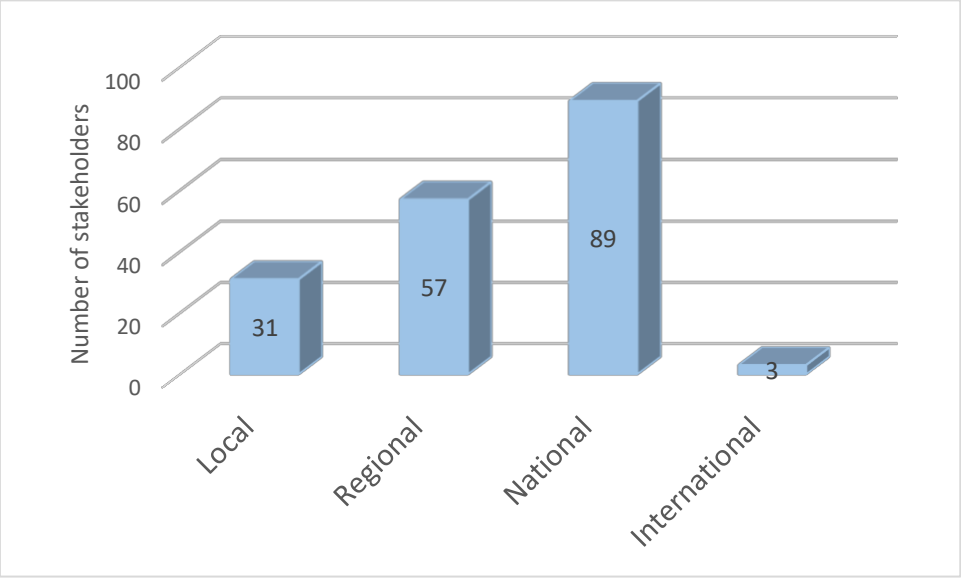


Figure 9. Geographical scope of the stakeholders in relation to their remit/functions.

When asked about what values are the stakeholders prioritising (with three choices possible), habitat/biodiversity was the most common first priority choice, followed by regulation of freshwater quantity location and timing (which was also most common second choice priority (Fig. 9). Pollination and food and feed were prioritised least (Fig. 10).

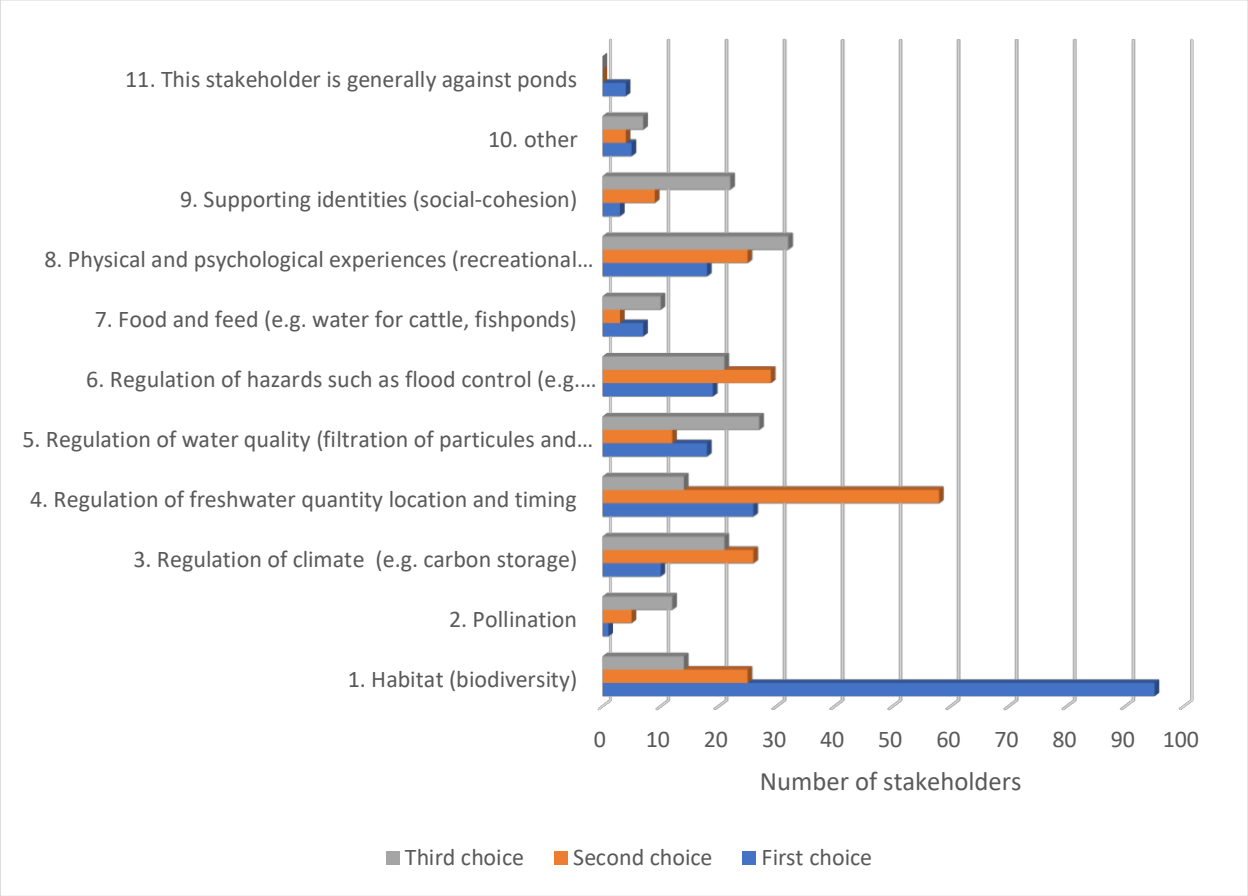


Figure 10. Number of stakeholders perceived as prioritising particular values of ponds, in order of priority (first, second and third choice).

Key terms in the PONDERFUL project: Glossary

In this section we provide definitions of the different terms as used in the project, and based on literature that are directly relevant to the topics covered by PONDERFUL, such as IPBES and IPCC reports.

Adaptation (to climate change)

In human systems, the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate and its effects (IPCC 2018). Note that this broad definition differs from the biological use of « adaptation », referring to genetic adaptation.

Agri-environmental schemes

Schemes that provide funding to farmers and land managers to farm in ways that supports biodiversity, enhance the landscape, and improve the quality of water, air and soil (see also agroecology as integral to such schemes) (IPBES 2019b).

Biodiversity

The variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems (CBD 1992, article 2). Biological diversity is often understood at four levels: genetic diversity, species diversity, functional diversity, and ecosystem diversity.

Carbon sink

A reservoir (natural or human, in soil, ocean, and plants) where a greenhouse gas, an aerosol or a precursor of a greenhouse gas is stored. Note that

UNFCCC Article 1.8 refers to a sink as any process, activity or mechanism which removes a greenhouse gas, an aerosol or a precursor of a greenhouse gas from the atmosphere (IPCC 2018a).

Carbon sequestration

The process of storing carbon in a carbon pool (IPCC 2018a). Carbon sequestration both occurs naturally (e.g. sequestration by trees or wetlands) or can be human-made (e.g. chemical scrubbing).

Climate change

A change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer (IPCC 2018).

Ecosystems-based Adaptation (EbA)

Ecosystem-based adaptation is the use of biodiversity and ecosystem services as part of an overall adaptation strategy to help people to adapt to the adverse effects of climate change (CBD 2009).

Eutrophication

Natural or artificial (anthropogenic) process of accumulation of nutrients in lakes or other bodies of water. Too much nitrogen and phosphorus in water can lead to an overgrowth of aquatic plants or algae, resulting in dense layers of scum on the surface of the water. This can damage fish, and other animals by depriving them of the oxygen.

Green-house gases (GHG)

Greenhouse gases are those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of terrestrial radiation emitted by the Earth's

surface, the atmosphere itself and by clouds. This property causes the greenhouse effect. Water vapour (H2O), carbon dioxide (CO2), nitrous oxide (N2O), methane (CH4) and ozone (O3) are the primary GHGs in the Earth's atmosphere. Moreover, there are a number of entirely human-made GHGs in the atmosphere, such as the halocarbons and other chlorine- and bromine-containing substances, dealt with under the Montreal Protocol. Beside CO2, N2O and CH4, the Kyoto Protocol deals with the GHGs sulphur hexafluoride (SF6), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs) (IPCC 2018a).

Governance

A comprehensive and inclusive concept of the full range of means for deciding, managing, implementing and monitoring policies and measures. Whereas government is defined strictly in terms of the nation-state, the more inclusive concept of governance recognizes the contributions of various levels of government (global, international, regional, sub-national and local) and the contributing roles of the private sector, of nongovernmental actors, and of civil society to addressing the many types of issues facing the global community (IPCC 2018).

Hydroperiod

The length of the period during which a pond holds water.

Indicator

"Indicators provide consolidated information, simplifying complex issues or phenomena into something simple and easily communicable. While indicators by definition are reductive, this simplification is useful for management. For example, it allows targets to be set, monitored, and evaluated, and communicated with non-expert stakeholders. Indicators should be accurate enough to capture main phenomena, but not too complex (or expensive) to monitor

IPCC

The Intergovernmental Panel on Climate Change is the UN body responsible for evaluating science related to climate change. In addition to understanding the interdisciplinary scientific basis of climate change, it is tasked with assessing impacts, risks, and identifying options for mitigating and adapting to climate change. The IPCC publishes regular general and thematic reports that assess and summarise published scientific literature to establish the state of knowledge (IPCC 2018).

IPBES

The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) is the intergovernmental body which evaluates science and assesses the state of biodiversity and of the ecosystem services it provides to society, in response to requests from decision makers.

IPBES assessment reports

Assessment reports are published outputs of scientific, technical and socioeconomic issues that take into account different approaches, visions and knowledge systems, including assessments of biodiversity and ecosystem services with a defined geographical scope, and thematic or methodological assessments based on the standard or the fast-track approach. They are to be composed of two or more sections including a summary for policymakers, an optional technical summary, and individual chapters and their executive summaries. Assessments are the major output of IPBES, and they contain syntheses of findings on topics that have been selected by the IPBES Plenary.

Land use change

Land use change refers to a change in the use or management of land by humans, which may lead to a change in land cover. Land cover and land use change may have an impact on the surface albedo, evapotranspiration, sources and sinks of greenhouse gases, or other properties of the climate system (IPCC 2000).

Land use, land-use change and forestry (LULUCF)

In the context of national greenhouse gas (GHG) inventories under the UNFCCC, LULUCF is a GHG inventory sector that covers anthropogenic emissions and removals of GHG from carbon pools in managed lands, excluding non-CO2 agricultural emissions (IPCC 2018a).

Mediterranean temporary ponds

Mediterranean temporary ponds are shallow ponds in the Mediterranean climate region that undergo a periodic cycle of flooding and drought and have a characteristic flora and fauna adapted to this alternation. They are considered a Priority Habitat according to the Habitats Directive (code 3170)., 92/43/EEC). Priority habitats are those habitat-types or elements with a unique or important significance to a diverse group of species.

Mitigation (of climate change)

A human intervention to reduce emissions or enhance the sinks of greenhouse gases (IPCC 2018).

Nature's Contributions to People

NCPs are all the contributions, both positive and negative, of living nature (i.e. all organisms, ecosystems, and their associated ecological and evolutionary processes) to people's quality of life. Beneficial contributions include e.g. food provision, water purification, flood control, and artistic inspiration, whereas detrimental contributions include e.g. disease transmission and predation that damages people or their assets. NCP may be perceived as benefits or detriments depending on the cultural, temporal or spatial context (Díaz et al., 2018). IPBES considers a gradient of approaches to NCP, ranging from a purely generalizing approach to a purely context-specific one. Within the generalizing approach, IPBES identifies 18 categories of NCP, organized in three partially overlapping groups:

• Material contributions are substances, objects or other material elements from nature that directly sustain people's physical existence and material assets.

They are typically physically consumed in the process of being experienced, for example when organisms are transformed into food, energy, or materials for clothing, shelter or ornamental purposes.

• Non-material contributions are nature's effects on subjective or psychological aspects underpinning people's quality of life, both individually and collectively. Examples include forests and coral reefs providing opportunities for recreation and inspiration, or particular organisms (animals, plants, fungi) or habitats (mountains, lakes) being the basis of spiritual or social-cohesion experiences.

• Regulating contributions are functional and structural aspects of organisms and ecosystems that modify environmental conditions experienced by people, and/or regulate the generation of material and non-material contributions. Regulating contributions frequently affect quality of life in indirect ways. For example, people directly enjoy useful or beautiful plants, but only indirectly the soil organisms that are essential for the supply of nutrients to such plants (IPBES 2019b).

Potential NCP

The capacity of an ecosystem to provide NCP (IPBES 2019b)

Realised NCP

The actual flow of NCP that humanity receives. Realized NCP typically depends not only on potential NCP but also anthropogenic assets (e.g., boats and fishing gear, or farm equipment), human labor, and institutions. Institutions can facilitate or prevent access to resources and are often important for determining whether or not potential NCP generates realized NCP.

Ecosystem Services (ES)

Direct and indirect contributions of ecosystems to human well-being (TEEB 2010). ES are often conceptualised using a cascade model (Potschin and Haines-Young 2016), where biophysical structures or processes lead to ecosystem functions that in turn provide ES. ES then give humans benefits that have value to them. In the context of the Common International

Classification of Ecosystem Services (CICES), they are biologically mediated (i.e. human-environmental interactions are not always considered ecosystem services).

Pond

Small standing water (in contrast to larger water bodies referred to as lakes). Surface area of ponds can vary from less than 1 m^2 to several hectares. Different upper surface areas have been proposed, often about 1-5 ha, sometimes more (e.g., Ramsar Convention: 8 ha). Ponds can vary strongly in terms of their ecology: being permanent, seasonal or ephemeral, man-made or naturally created. Most ponds are shallow and therefore lack a stable stratification.

Pondscape

A pondscape is a landscape including a congregation of ponds with spatial proximity ("connectedness") that potentially influences local species persistence and community structure (see Boothby 1997). Regular or sporadic exchange of species from one pond to another in the pondscape can increase local diversity, buffer for species extinction due to chance or local disturbances, and thus influence community structure. The boundaries of a pondscape may vary and may be determined by physical or ecological settings (a valley, a catchment, a set of ponds in a nature reserve) or even determined by societal or political criteria (urban ponds, provincial or national boundaries). Connectedness in a given pondscape is a function of ecological differences among ponds, the terrestrial matrix (facilitating or impeding dispersal) and dispersal capacity of the organisms, and thus also depends on the taxonomic group considered. The total surface area covered by a pondscape can strongly vary.

Stakeholders

In policy science, a stakeholder is any group or individual who can affect or is affected by a public policy, both directly and indirectly. In PONDERFUL, stakeholders are defined as groups or individuals that affect or are affected by ponds and their management.

Wetlands

According to the Ramsar Convention on Wetlands (1994), “wetlands are areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres.” As specified by the Ramsar Classification System for Wetlands Types, naturally occurring as well as human-made ponds (below 8 hectares) are wetlands.

References

Biggs, J. et al. 2017. The importance of small waterbodies for biodiversity and ecosystem services: implications for policy makers. Hydrobiologia 793, 3-39 .

Blicharska, M. 2017. Shades of grey challenge practical application of the Cultural Ecosystem Services concept. Ecosystem Services 23, 55-70.

Boothby, J. 1997. Pond conservation: towards a delineation of pondscape. Aquatic Conserv: Mar. Freshwater Ecosystems 7, 127-132.

Burkhard, B. et al. 2012. Mapping ecosystem service supply, demand and budgets. Ecological Indicators 21, 17-29.

Cardinale, B.J. et al. 2012. Biodiversity loss and its impact on humanity. Nature 486, 59-67.

CBD (United Nations Convention on Biological Diversity) 2009. Connecting biodiversity and climate change mitigation and adaptation: Key messages from the report of the Second Ad Hoc Technical Expert Group on Biodiversity and Climate Change (2009) https://www.cbd.int/doc/publications/ahteg-brochure-en.pdf

Cohen-Shacham, E. et al. 2016. Nature-based Solutions to address global societal challenges. Gland, Switzerland: IUCN.

Daily, G.C. (Ed) 1997. Nature's Services: Societal Dependence on Natural Ecosystems. Island Press, Washington DC

Davidson, T.A. et al. 2018. Synergy between nutrients and warming enhances methane ebullition from experimental lakes. Nature Climate Change 8156-160

Davies B.R. et al. 2008. Comparative biodiversity of aquatic habitats in the European agricultural landscape. Agriculture, Ecosystems & Environment 125,1-8.

Díaz S, Demissew S, Joly C, Lonsdale WM, Larigauderie A. 2015. A Rosetta Stone for nature's benefits to people. PLoS Biol. 13:e1002040.

Díaz S et al. 2018. Assessing nature's contributions to people. Science 359, 270-272.

Downing, J.A. et al. 2006. The global abundance and size distribution of lakes, ponds, and impoundments. Limnology and Oceanography Methods 51, 2388-2397.

Dye, T.R. 1972. Understanding Public Policy. Prentice Hall, Englewood Cliffs, NJ.

EEA. 2020. Indicator assessment: Nationally designated terrestrial protected areas in Europe (CSI 008, SEBI 007). Prod-ID: IND-142-en. Accessed: 18 March 2021. https://www.eea.europa.eu/data-and-maps/indicators/nationally-designated-protected-areas-1/assessment

EC. 2021. European Commission, The EU and nature-based solutions. https://ec.europa.eu/info/research-and-innovation/research-area/environment/nature-based-solutions_en

EEA. 1995. A General Strategy for Integrated Environmental Assessment at EEA. Internal Report European Environment Agency, Copenhagen: 20 pp.

EEA. 2020. Indicator assessment: Nationally designated terrestrial protected areas in Europe (CSI 008, SEBI 007). Prod-ID: IND-142-en. Accessed: 18 March 2021. https://www.eea.europa.eu/data-and-maps/indicators/nationally-designated-protected-areas-1/assessment

Eggermont, H. et al. 2015. Nature-based solutions: New influence for environmental management and research in Europe. GAIA, 24, 243-248.

Ehrlich, P., Ehrlich, A. 1981. Extinction: The Causes and Consequences of the Disappearance of Species. Random House, New York

EPCN 2008. The Pond Manifesto. European Pond Conservation Network.

Fernandez, S. et al. 2014. Bringing politics back into water planning scenarios in Europe. Journal of Hydrology 518, 17-27.

Faivre, N. et al. 2017 Nature-based solutions in the EU: innovating with nature to address social, economic and environmental challenges. Environmental Research 159, 509-518.

Gozlan, R.E. et al. 2019. Status, trends, and future dynamics of freshwater ecosystems in Europe and Central Asia. Inland Waters 9, 78-94

Gupta, J. et al. 2020. Re-imagining the driver-pressure-state-impact-response framework from an equity and inclusive development perspective. Sustainability Science 15, 503-520.

Haines-Young, R., Potschin, M.B. 2018. Common International Classification of Ecosystem Services (CICES) V5.1 and Guidance on the Application of the Revised Structure

Harrison, P.A. et al. 2014. Linkages between biodiversity attributes and ecosystem services: a systematic review. Ecosystem Services, 9, 191-203.

Hill, M.J. et al. 2018. New policy directions for global pond conservation. Conservation Letters 11(5): e12447.

Holgerson, M.A., et al. Large contribution to inland water CO2 and CH4 emissions from very small ponds. Nature Geoscience, 2016. 9: 222-226.

Howlett, M. 2011. Designing public policies. Principles and instruments. New York, NY: Routledge.

IPBES. 2019a. Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. E. S. Brondizio, J. Settele, S. Díaz, and H. T. Ngo (editors). IPBES secretariat, Bonn, Germany.

IPBES. 2019b. IPBES Glossary; https://ipbes.net/glossary

IPCC. 2000. Land Use, Land-Use Change, and Forestry. Robert T. Watson, Ian R. Noble, Bert Bolin, N. H. Ravindranath, David J. Verardo and David J. Dokken (Eds.) Cambridge University Press, UK. pp 375 Available from Cambridge University Press, The Edinburgh Building Shaftesbury Road, Cambridge CB2 2RU ENGLAND.

IPCC. 2018a. Annex I: Glossary [Matthews, J.B.R. (ed.)]. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)].

IPCC. 2018b. IPCC Factsheet: What is the IPCC. https://www.ipcc.ch/site/assets/uploads/2018/02/FS_what_ipcc.pdf

Kabisch, N. et al. 2016. Nature-based solutions to climate change mitigation and adaptation in urban areas: perspectives on indicators, knowledge gaps, barriers, and opportunities for action. Ecology and Society 21, 39.

Levin S. et al., 2013. Social-ecological systems as complex adaptive systems: modeling and policy implications. Environment and Development Economics 18, 111-132.

Liquete, C. et al. 2013. Current Status and Future Prospects for the -ssessment of Marine and Coastal Ecosystem Services: A Systematic Review. PloS One 8

Loreau, M. Et al. 2003. Biodiversity as spatial insurance in heterogeneous landscapes. PNAS 100, 12765-12770.

MA 2005. Millennium Ecosystem Assessment.

Martinez-Harms MJ, Balvanera P, 2012. Methods for mapping ecosystem service supply: a review. International Journal of Biodiversity Science, Ecosystem Services & Management 8, 17-25.

Milcu A, et al. 2013. Cultural Ecosystem Services: A Literature Review and Prospects for Future Research. Ecology and Society 18, 44.

Merilä, J., Hendry, A.P. 2014. Climate change, adaptation, and phenotypic plasticity: the problem and the evidence. Evolutionary Applications, 7, 1-14.

Naumann, S, Davis, M. 2020. Biodiversity and Nature-Based Solutions: Analysis of EU Funded Projects. European Commission, Directorate General for Research and Innovation. https://data.europa.eu/doi/10.2777/183298.

Pascual, U. et al. 2017. Valuing nature's contributions to people: the IPBES approach. Current Opinion in Environmental Sustainability 26-27, 7-16.

Persson, A., Runhaar, H. 2018. Conclusion: Drawing lessons for Environmental Policy Integration and prospects for future research. Environmental Science and Policy 85, 141-145.

Pletterbauer, F. et al. 2016. "Drivers of change and pressures on aquatic ecosystems: AQUACROSS Deliverable 4.1", European Union's Horizon 2020 Framework Programme for Research and Innovation Grant Agreement No. 642317.

Potschin, M., Haines-Young, R. 2016. Defining and measuring ecosystem services. In: Potschin, M.,

Haines-Young, R., Fish, R. and Turner, R.K. (eds) Routledge Handbook of Ecosystem Services.

Routledge, London and ä New York, pp 25-44.

Runhaar, H. 2014. Towards a Systematic Framework for the Analysis of Environmental Policy Integration. Environmental Policy and Governance 24, 233-246.

Seddon, N. et al. 2020. Understanding the value and limits of nature-based solutions to climate change and other global challenges. Philosophical Transactions of the Royal Society B 375, 20190120.

Science for Environment Policy. 2021 The solution is in nature. Future Brief 24. Brief produced for the European Commission DG Environment. Bristol: Science Communication Unit, UWE Bristol.

Taylor, S., et al. 2019 Frontiers in Ecology and the Environment 17, 25-31.

TEEB, 2010. The Economics of Ecosystems and Biodiversity: Mainstreaming the Economics of Nature: A synthesis of the approach, conclusions and recommendations of TEEB.

Wild, T.C. et al. 2017. Comprehending the multiple 'values' of green infrastructure - valuing nature-based solutions for urban water management from multiple perspectives. Environmental Research, 158: 179-187.

Williams P. et al. 2004. Comparative biodiversity of rivers, streams, ditches and ponds in an agricultural landscape in Southern England. Biological Conservation 115, 329-341.

Yachi, S., Loreau, M. 1999. Biodiversity and ecosystem productivity in a fluctuating environment: The insurance hypothesis. PNAS 96, 1463-1468.

Annex 1

Guidance for stakeholder mapping for DEMO-sites, prepared by WP 1, 2020-12-18

INTRODUCTION

Stakeholder involvement is an important part of PONDERFUL work and it should start early on, to enable their meaningful contribution to the project. Mapping of stakeholders is an important first step in this process for all the DEMO-sites. The aim of the mapping is to gather basic information about key stakeholders, with particular focus on their interest in the project and their impact (power). This can help DEMO-sites in planning, launching and organising the DEMO-site work, and particularly organisation of the three stakeholder workshops. For some partners, the exercise of stakeholder mapping may also be useful for selection of the DEMO-site to be used in the project.

Stakeholder mapping is also a part of PONDERFUL concept note (Milestone 5) to be ready in Month 5 (April 2020).

KEY TERMS

A stakeholder in policy science is any group or individual who can affect or is affected by a public policy.

In case of PONDERFUL, relevant stakeholders are groups of individuals that can affect or be affected by policy decisions that are relevant for ponds and pondscapes. Such decisions do not need to directly consider ponds or pondscapes as such, but could be e.g. decisions in different sectors that have impact on ponds and pondscapes, e.g. decisions in nature conservation sector, decisions concerning climate change, spatial planning decisions, management decisions (e.g. about creation and/or maintenance of ponds). Relevant stakeholders include both public and private stakeholders.

Examples of stakeholders:

Public stakeholders:

Local authorities (e.g. municipalities, water management authorities)

Water management bodies (e.g. regional water boards)

Regional authorities (e.g. county boards)

National authorities (e.g. Environmental Protection Agency, National water authority, national agricultural authority, Forest and Nature Agency?)
Universities, research institutes (with relevant experts) working on the site

Private stakeholders:
Private land owner and land owners' associations
Farmers and farmer associations
Non-governmental organisations (NGOs), e.g. working with environmental issues, with water, with conservation, etc.
Citizen science organisations
Companies (e.g. consultancy companies)
Industry that impacts ponds (e.g. nearby power plants or industrial sites)
Local technical companies (for dredging, restoration of ponds)

Public policy is "what government chooses to do or not to do" to maintain social order and address the needs of its citizens (Dye, 1972). Policies are thus choices that are results of governmental decisions. The decision makers can be found at many different governance levels, from local (e.g. municipality) to regional and national (e.g. nature conservation agency at national level). The policies can also take many forms, e.g. legal acts, ordinances, decrees, different types of strategies (at local, regional or national level), spatial plans, or even guidelines and recommendations issued by different authorities. Note that a policy does not always have a legal power, is not legally binding (like legal acts, etc.), but still it may "steer" decisions in some way.
One can discuss policy content (substantive perspective) and the process through which policies are made (procedural perspective). Content-wise, policies include policy goals (basic aims and expectations) and policy means (instruments to implement policy). *Policy goals* can be either general objectives (e.g. a vision for something) or very specific targets (e.g. % of something to be achieved). *Policy means* (instruments) can be of different types - could be legal (e.g. some legal regulations), economic and financial (e.g. incentives in form of tax reduction), information (e.g. information campaign). The policy process is often referred to as a policy cycle, with five stages: agenda-setting (problem recognition), policy formulation (proposal for solution), decision-making (selection of solution), policy implementation (putting solution into effect), policy

evaluation (monitoring results). The evaluation may lead to reconceptualization of problems and a start of a new policy cycle (Howlett 2011).

WHY INVOLVE STAKEHOLDERS IN PUBLIC POLICY?

Stakeholders can contribute to every step of the policy cycle: they can help identify problems, co-develop solutions, rank or select potential solutions, help implement the policy on the ground, and contribute to policy evaluation. Including stakeholders has many benefits (Reed et al. 2009). Their expertise can help design better and more creative policy. Involving stakeholders throughout the process can increase stakeholder ownership and buy-in, decreasing opposition to policy and supporting effective implementation. There are also moral arguments for involving stakeholders, especially for policies that affect common resources (like pond biodiversity, climate, etc.): as stakeholders are directly impacted or affected, they should contribute to decision making.

STAKEHOLDER MAPPING INSTRUCTIONS

We would like each DEMO-site to provide us with a Table (see below) filled in with the following information about stakeholders in their area:

Stakeholder type and subtype: Type: public or private; Subtype: policy, science, business, other (including scientists, NGOs

Stakeholder: name of the stakeholder: here we would like you to be as specific as possible, i.e. you could write a stakeholder such as “municipality xx”, but it is even better if you could provide name/s of actual representatives of that municipality that could be relevant for the project (this of course is only possible if you already have an established contact with specific people).

Gender: of the representative or spokesperson (We need to have disaggregated data to know the presence of women (and their power position) in public and private stakeholders’ organizations)

Name, contact information: provide that, if available (if e.g. you have already had contact with particular people). This column is aimed to help you have all contact information in place for your own DEMO-site work. We, in WP1, do not really need that, as we will not directly communicate with your stakeholders. So, feel in this column, but you may choose to keep it for yourself and send as a table without this particular column (e.g. due to GDPR reasons).

Stakeholder's role: shortly describe the role of stakeholder in relation to ponds/pondscapes. This could be, e.g. decision making (e.g. regarding pond creation and management, conservation measures, or climate mitigation policies), management and/or planning, advisory role, creation of ponds, consultation, knowledge development, etc.

Interest: evaluate on the scale from 1 to 3 the level of interest of the stakeholder in the PONDERFUL project and in your planned work in the DEMO-site. 1 indicates rather low interest (e.g. willingness to only get some information about the project), while 3 indicates very high interest (e.g. potential willingness to participate in stakeholder workshops, provide advice, use project's results, etc.). Use your own judgement and experience from the previous contacts (if any) with the stakeholder.

Impact: evaluate on the scale from 1 to 3 the level of potential impact the stakeholder may have on decisions relevant for ponds/pondscapes. The impact is linked to stakeholder's power - note that power particular stakeholders have may be formal (i.e. power attributed by law) or informal (capacity of stakeholders to influence the actions, policies, or decisions that in not regulated by law). Informal power may e.g. be reflected in lobbying. Formal power is most commonly attributed to public sector (authorities), but can also be attributed to private stakeholders (e.g. in the form of regulated interaction between governments and influential organized lobby groups, e.g. consultation roundtables, or in form of joint public-private partnerships for resource management). The impact/power of a stakeholder can be determined by different factors, e.g. legal authority (empowerment by law), knowledge and expertise, economic relevance of stakeholder (e.g. in a region important for agricultural production, farmers association may have large power to influence decisions about water management), access to other key stakeholders (such as high-level politicians, important businessmen, etc.), reputation, relationships with media, etc.

For Interest and Impact, it is enough to provide the score (from 1 to 3). However, if you wish to add comments explaining the reason for the score level, you are also very welcome to do that.

Collaboration in place: describe shortly how advanced is your collaboration with particular stakeholder, e.g. advanced collaboration; some collaboration; no collaboration at all yet (need to make initial contact).

Stakeholder type	Stakeholder	Gender	Name, contact info	Stakeholder's role	Interest	Impact	Collaboration in place

Please, send the filled Table to Gosia (WP1) latest on **27th January**: malgorzata.blicharska@geo.uu.se

Please, do not be late, as we need time to synthesise this information to be presented on the Kick-off meeting.

References

Dye, T.R. 1972. Understanding Public Policy. Prentice Hall, Englewood Cliffs, NJ.

Howlett, M. 2011. Designing public policies. Principles and instruments. New York, NY: Routlegde.

Reed, M.S., Graves, A., Dandy, N., Posthumus, H., Hubacek, K., Morris, J., Prell, C., Quinn, C.H., Stringer, L.C. 2009. Who's in and why? A typology of stakeholder analysis methods for natural resource management. Journal of Environmental Management, 90, 1933-49.

Annex 2

Stakeholder mapping step 2 - instructions

Thank you for providing WP1 with the first lists of stakeholders and thus contributing to PONDERFUL Concept Note. As agreed on Kick-off meeting, the second step of stakeholder mapping should take place in March 2021. Deadline for Concept Note Milestone 5 is in April 2021.

The idea with the second step of stakeholder mapping is to gather a little more information to help us understand the decision-making processes that are relevant for ponds and pondscapes, and to understand the role of particular stakeholders in different decisions.

There can be different types of decisions when it comes to ponds and pondscapes:

1. Decisions about pond creation: if to build/create a pond, what type of pond (and thus why to do it, what is the motivation), when to do it, where to locate it, how to do it and from what sources will it be financed
2. Management decisions: if to manage a pond (and which ponds in a pondscape to manage), and why, what kind of management could/should be conducted, how often, and who will finance that.
3. Decisions that could potentially prioritise other use of land than creation of pond/s, e.g. farmers filling in/draining ponds or spatial planning decisions promoting other land use,
4. Decisions that do not directly deal with ponds, but may (negatively) impact them, i.e. land use and management impacting ponds, e.g. pig farms in Spain, urban areas in Turkey.
5. Decisions related to recreational activities associated with the creation of ponds
6. Decisions concerning biodiversity conservation, e.g. specific protection forms or management that promotes conservation... *and other decisions...*

All of the above means that when identifying stakeholders who are relevant, one needs to think about questions such as:

1. Who built or restore the site and when?
2. Who owned the land
3. Who owns the land now

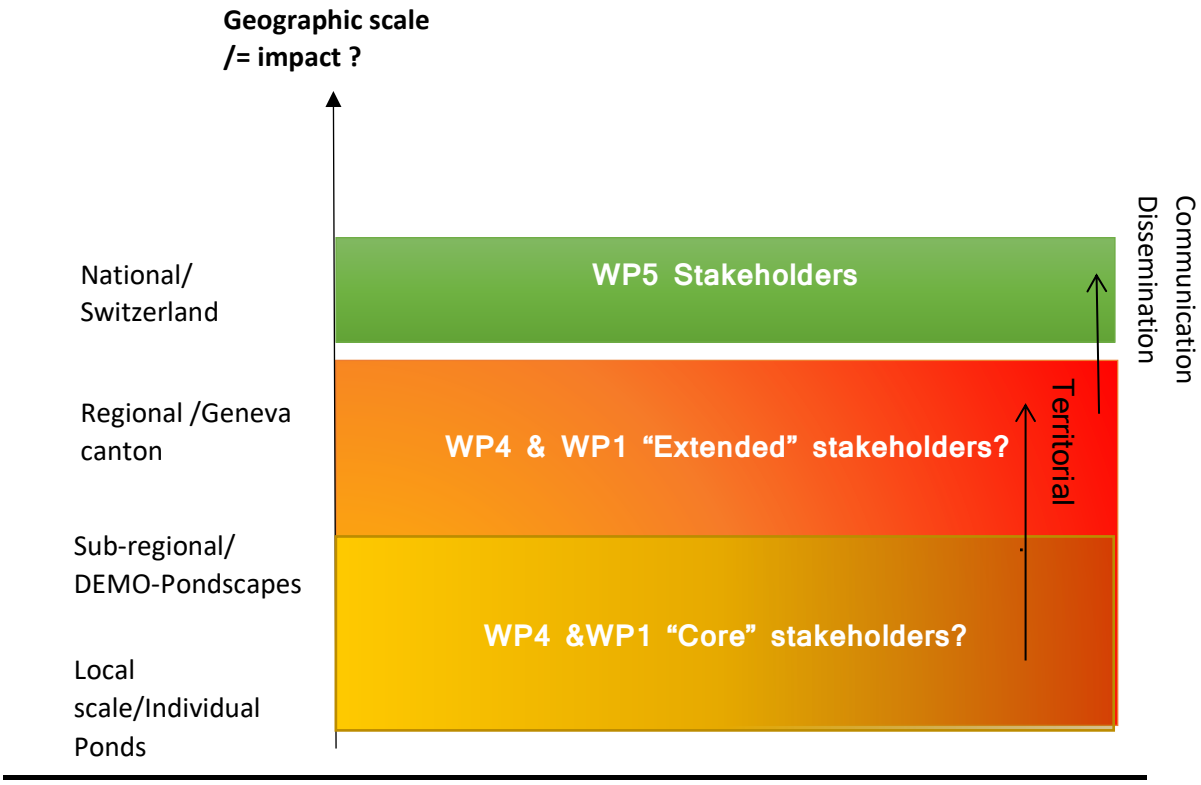
4. Who manages the site/land?
5. Who is interested in their management? And why?
6. Who does research in the site and why?
7. Who visits the site and what for?
8. Where does money come from?
9. What was the original purpose of the pond and what are the uses now?
10. What is the management applied to the pond?
11. Who would be against pond creation or management
12. What activities in the area may influence ponds and who is responsible for them?
13. Who needs to provide an authorization for pond creation?

Having all of that in mind, we would like you to come back to your initial stakeholder mapping list and complement it with more detailed information about the roles of particular stakeholders in relation to different decisions relevant for ponds and pondscapes. See attached Table in Excel. For each stakeholder that you listed **mark with either "Yes" (Y) or "No" (N) in each column** (besides last two columns, where you need other type of response, see the template). If you leave a field empty, we assume that it means "No". Please, list the stakeholders in the same order as you did in first mapping, so we can easily find information also about their power and interest from previous mapping and connect to information that you will provide in this second step.

You are also very welcome to expand your previous stakeholder list and add new/more stakeholders.

Note: This mapping exercise should include stakeholders that are relevant (i.e. core and extended stakeholders, see figure below with example from Swiss DEMO-site), but not WP5 stakeholders (which will be then the focus of WP5 dissemination).

Please, provide the information to us by **25 March** (Milestone must be ready in April!)



Stakeholders 1: "core" stakeholders (yellow square). It is the minimum and easiest mapping to do (with the assumption their nature won't change in long-term horizon). The limit is the geographic scale = Sub-regional/ DEMO-Pondscape (in Swiss case they represent less than 10% (5%?) of the surface area of Geneva canton and already protected, land use changes should not threat them in the future!).

Stakeholders 2: spatial extension to regional scale (yellow + red square). We take into account the land use changes scenarios, the pressures implied, and their potential threats we will have to overcome to create/promote new pondscapes in other areas (in cities for example!). It implies potentially additional actors of territorial management/plan of the region. Eg: Urbanization department, parks and gardens services, municipalities, main landowners (farmers, forest owners and exploitant), ponds users for recreation (citizens, fishermens). Such stakeholders can be e.g. relevant in connection to column C in the template: "Own the land where a pond can potentially be created". In Swiss case most ponds of the selected DEMO-pondscapes owned to the state of Geneva.

Stakeholders 3: Dissemination to end-users at a national level (green square): "WP5" stakeholders and end-users database (D 5.3).

Ponderful

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Horizon2020
European Union Funding
for Research & Innovation

Pond Ecosystems for Resilient Future Landscapes in a Changing Climate

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No ID 869296